U.S. DEPARTMENT OF COMMERCE
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PB-276 356

Sample Fugitive Lead Emissions from Two Primary Lead Smelters

Midwest Research Inst, Kansas City, Mo

Prepared for

Environmental Protection Agency, Research Triangle Park, N C Office of Air Quality Planning and Standards

Oct 77

EPA-450/3-77-031
October 1977

PB 276 356

SAMPLE FUGITIVE LEAD EMISSIONS FROM TWO PRIMARY LEAD SMELTERS

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA-450/3-77-031

2\.

3. RECIPIENT'S ACCESSION NO.
PB276356

4. TITLE AND SUBTITLE
Sample Fugitive Lead Emissions from Two Primary Lead Smelters

5. REPORT DATE
October 1977

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Paul Constant, Mark Marcus, William Maxwell

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Midwest Research Institute
425 Volker Boulevard
Kansas City, Missouri 64110

10. PROGRAM ELEMENT NO.
2AF 643

11. CONTRACT/GRANT NO.
68-02-1403, Task 26

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

13. TYPE OF REPORT AND PERIOD COVERED
Final

14. SPONSORING AGENCY CODE
200/04

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Fugitive sampling of particulate was performed at two primary lead smelters. Total fugitive particulate mass emission rates, total emission rate of arsenic and lead, lead content by particle-size range, chemical species containing lead, and particle density were determined for each smelter. High volume air samplers were used to collect mass particulate samples. These samples were analyzed by gravimetric procedures, by electron spectroscopy for chemical analysis (ESCA), and by x-ray diffraction.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Fugitive lead emission rate	Fugitive emissions	
Fugitive arsenic emission rate	Primary lead smelters	
Lead content by particle-size range	Particle density	
Fugitive emissions lead species	Chemical species	

18. DISTRIBUTION STATEMENT
Unlimited

19. SECURITY CLASS *(This Report)*
Unclassified

20. SECURITY CLASS *(This page)*
Unclassified

21. NO. OF PAGES
435

22. PRICE
A19-A01

EPA Form 2220-1 (9-73)

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by

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Contract No. 68-02-1403
Task No. 26
Program Element No. 2AF643

EPA Project Officer: David Barrett

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

October 1977

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Publication No. EPA-450/3-77-031

FOREWORD

Midwest Research Institute (MRI), under Task 26 of EPA Contract No. 68-02-1403, conducted a fugitive emission, sampling and analysis test at each of two ASARCO (American Smelting and Refining Company) primary lead smelters: the Glover, Missouri, plant, and the East Helena, Montana, plant.

The results of MRI's sampling and analysis efforts are given in this report. A summary of the results of the tests is given in Section II; the sampling and analysis procedures are given in Sections V and VI, respectively. There are 14 appendices which cover plant layout, sampling and other equipment used, field data, results of chemical analysis (in chart form), and mathematical calculations.

The task was conducted under the technical management of Mr. Paul C. Constant, Jr., Program Manager. He was assisted by Mr. William Maxwell, who supervised field activities; Messrs. John LaShelle, James Barnett, and Edward Cartwright, who worked with Mr. Maxwell in the field sampling activities; Dr. Mark Marcus, who headed the chemical analysis effort, and who was assisted by Ms. Carol Green and others; Mrs. Rose Bartels, who performed mathematical calculations; and Dr. Chatten Cowherd who assisted on a consulting basis. Physical Electronic Industries analyzed some of the samples by ESCA (electron spectroscopy for chemical analysis) and Walter C. McCrone Associates, Inc., analyzed some of the samples by X-ray diffraction.

The assistance of Mr. K. W. Nelson, Vice President, Environmental Affairs of ASARCO, Inc., in arranging for MRI to test at the two ASARCO plants, and the fine cooperation of Mr. S. M. Lane and his staff at the East Helena, Montana, plant and that of Mr. C. F. Bates and his staff of the Glover, Missouri, plant is gratefully acknowledged.

Acknowledgment is made to Messrs. Mark A. Scruggs, David H. Barrett, Connally Mears, and Gary McCutchen, all of the Environmental Protection Agency for their critical review of this report, and their excellent suggestions that were incorporated into this report.

Approved for:

MIDWEST RESEARCH INSTITUTE

L. J. Shannon

L. J. Shannon, Director
Environmental and Materials
Sciences Division

October 18, 1977

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I. INTRODUCTION

The purpose of the work performed under EPA Contract No. 68-02-1403, Task No. 26, Task Change No. 1, was to sample fugitive emissions at two primary lead smelters to obtain the following information:

1. Total particulate mass (fugitive) emission rate;
2. Total emission rate of lead and arsenic;
3. Lead content by particle-size range;
4. Chemical species containing the lead; and
5. Particle density.

Fugitive (nonconfined or ducted) emissions comprise two types: fugitive dusts, which are those from open areas such as storage piles and open transfer points--backhoe transfer from truck to bins; and process fugitives, which are those that come from the process operations themselves but are not confined or ducted.

It was important to the Environmental Protection Agency (EPA) that this task be performed with dispatch so that results would be available to EPA the end of August 1976. As a consequence, specific subtasks were accelerated in an attempt to meet this need.

Prior to receipt of the task order, Midwest Research Institute (MRI) sent to EPA on May 7 a list of representative primary lead smelters and battery plants.* EPA made the initial contacts with the lead smelters, and notified MRI the 2nd week of June 1976, that the two smelters to test were those of the American Smelting and Refining Company (ASARCO) located in Glover, Missouri, and East Helena, Montana. On June 15, MRI, in conjunction with EPA, conducted a preliminary survey of the Glover plant. On June 17, they made a preliminary survey of the East Helena plant.

It would be desirous to measure specific fugitive emissions. In most cases this is extremely difficult because the emissions are random, or they are short in duration, or there is no good way to measure air flow, or sampling isokinetically was not possible, or obtaining truly representative samples was not possible, or combinations of these various reasons. Consequently, fugitive emissions from an entire operation, such as from the individual processes of a sinter building, were considered as one fugitive source. One must also recognize that this was not an exhaustive test with only limited replication of sampling to increase the significance of results.

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* These were later deleted from the task order by a task order change and two lead smelters replaced both type processes.

The sampling locations, jointly agreed upon by MRI and EPA as a result of their preliminary surveys, are identified in Figures 1 and 2. More specific information on the sampling locations, their priority, and general remarks is given in Tables 1 and 2. A condition of MRI's testing was that processing data would not be available to them.

The sampling at the locations given above was conducted by MRI personnel during the following periods: July 6 to 16 at the ASARCO plant in Glover, Missouri; and July 21 to 30 at the ASARCO plant in East Helena, Montana.

On July 13, MRI personnel met with personnel of the American Building Company of Helena, Montana. The East Helena plant was visited, and a bid was obtained for the modifications that were needed to prepare the site for sampling. This bid was subsequently approved by EPA. The modifications were completed on July 20.

The site modifications at the East Helena plant were quite extensive, costing $12,500. These modifications are summarized below by location number (Table 2):

Location	Modifications
11	Sampling platform with safety rails was constructed around three sides of the opening (Figure B-3, Appendix B). An access walk platform with safety rails was constructed from existing roof walkway to sampling platform.
17 and 18	A double section 70-ft scaffold was erected and secured to the dross-kettle operation/reverbatory-furnace operation building. A sampling platform (Figure B-10, Appendix B) was constructed along the entire length of the roof opening (which was the length of the building). A cross-over platform (Figure B-9, Appendix B) was constructed over the dross operation and the reverbatory operation so that sampling could be done at these points. These cross-over platforms spanned the 15-ft roof vent at the two points. Safety rails were around all platform areas.
19	A 5 ft x 5 ft sampling platform was constructed. This platform was suspended 15 ft above the blast furnace, charge input area. The roof opening was just above the platform.
21	Scaffold was erected (Figure B-16, Appendix B).
23	An overhanging platform was constructed.

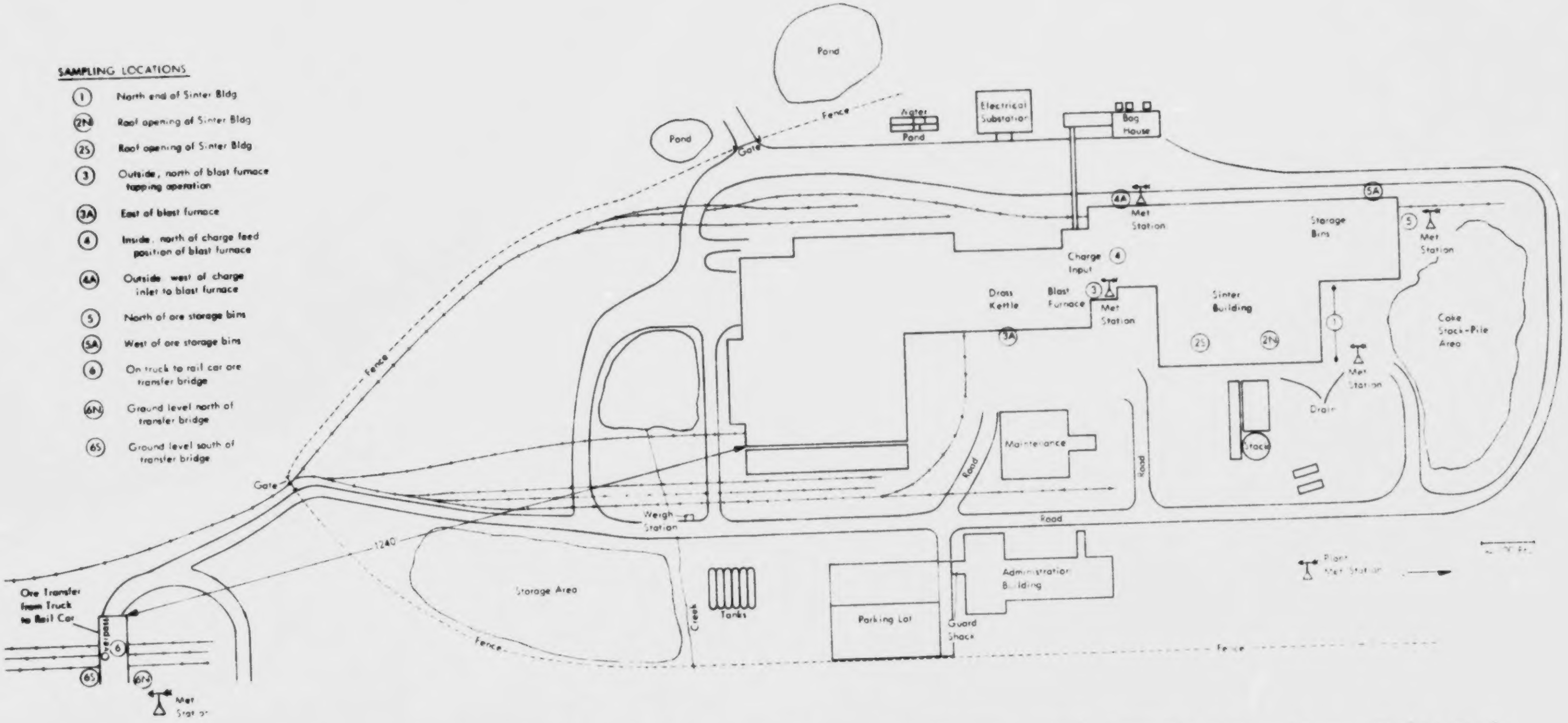
SAMPLING LOCATIONS
① North end of Sinter Bldg
(2N) Roof opening of Sinter Bldg
(2S) Roof opening of Sinter Bldg
③ Outside, north of blast furnace tapping operation
(3A) East of blast furnace
④ Inside, north of charge feed position of blast furnace
(4A) Outside west of charge inlet to blast furnace
⑤ North of ore storage bins
(5A) West of ore storage bins
⑥ On truck to rail car ore transfer bridge
(6N) Ground level north of transfer bridge
(6S) Ground level south of transfer bridge
Pond
Pond
Fence
Gate
Water
Pond
Electrical Substation
Bag House
Met Station
Storage Bins
Met Station
Charge Input
Dross Kettle
Blast Furnace
Met Station
Sinter Building
Coke Stack-Pile Area
Met Station
Drain
Stack
Maintenance
Road
Road
Road
Weigh Station
Gate
1240
Fence
Ore Transfer from Truck to Rail Car
Overpass
Met Station
Storage Area
Creek
Tanks
Parking Lot
Guard Shack
Administration Building
Fence
Plant Met Station

Figure 1 - Overall Layout of ASARCO Lead Smelter at Glover, Missouri, with Sampling Locations Indicated

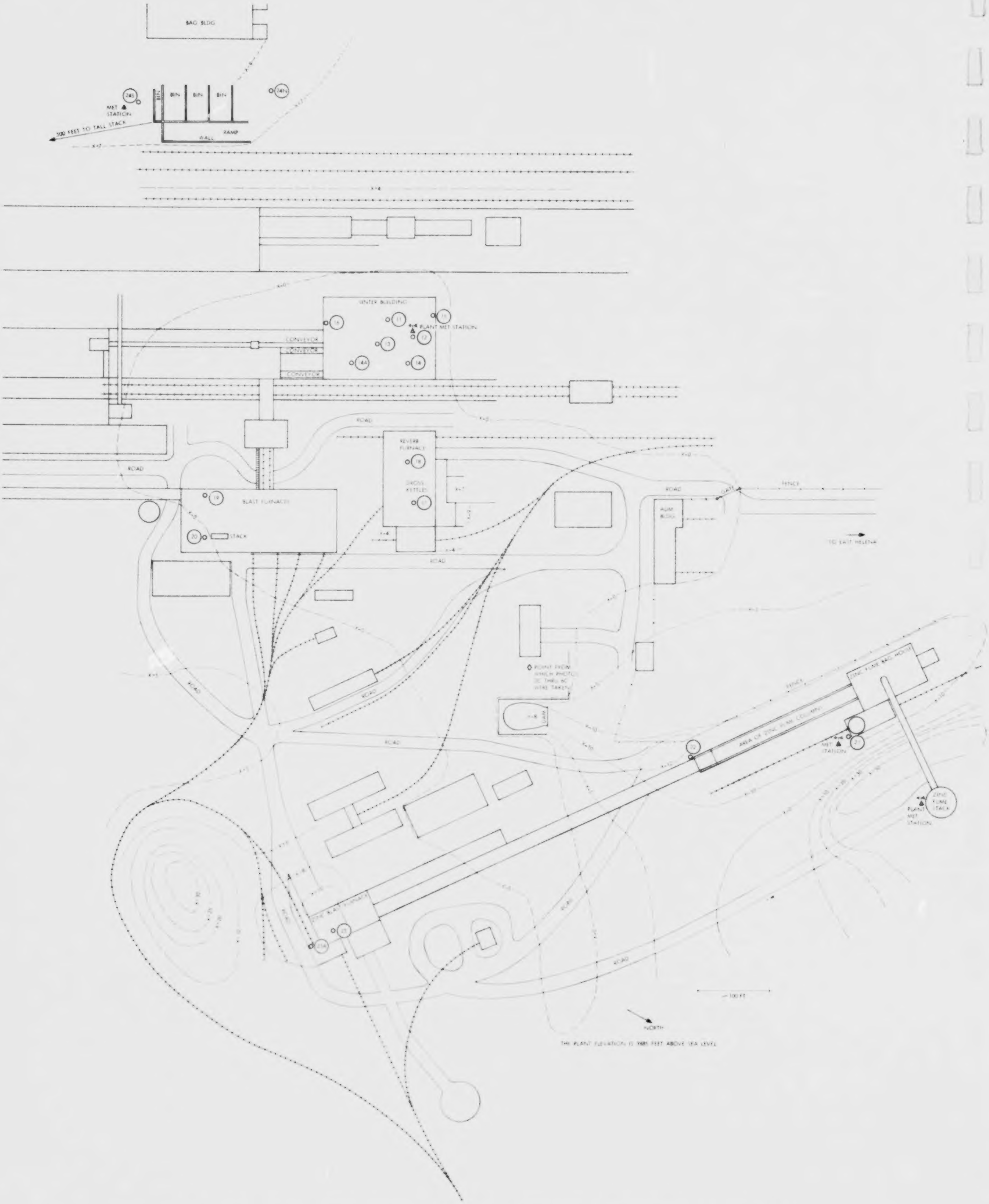
BAG BLDG
BIN
BIN
BIN
BIN
24S
MET STATION
24N
500 FEET TO TALL STACK
RAMP
WALL
x=2
x=4
x=0
SINTER BUILDING
16
11
15
PLANT MET STATION
12
13
14A
14
CONVEYOR
CONVEYOR
CONVEYOR
ROAD
REVERB FURNACE
18
DROSS KETTLES
17
x=7
x=4
ROAD
BLAST FURNACES
19
20
STACK
ROAD
ADM BLDG
GATE
FENCE
TO EAST HELENA
POINT FROM WHICH PHOTOS 3C THRU 8C WERE TAKEN
x=8
DAM
x=10
ROAD
FENCE
ZINC FUME BAG HOUSE
AREA OF ZINC FUME COLUMN
22
21
MET STATION
ZINC FUME STACK
PLANT MET STATION
x=20
x=30
ZINC BLAST FURNACE
23
23A
ROAD
ROAD
ROAD
100 FT
NORTH
THE PLANT ELEVATION IS 3985 FEET ABOVE SEA LEVEL

Figure 2 - General Plant Plan View, Indicating Locations 11 to 24S

TABLE 1

SAMPLING LOCATIONS AT GLOVER, MISSOURI, PLANT

Sampling Locations[a]			
No.	Point	Priority	Remarks
1	Sinter building[b] - north side	High	Sampling with a special vertical profile apparatus[c] at two vertical points traversing this side of building, which is open.
2	Sinter building[d] - roof openings	High	Sampling with HiVol samplers[e] and 5-stage impactor[f] in two roof openings. We were not allowed on the roof because it was unsafe.
3	Blast-furnace area[g] - dross-kettle pouring	High	HiVol samplers[h] and 5-stage impactor[f] in the vicinity of the dross-kettle pouring operation. Pouring takes place intermittently every 45 min.
4	Blast-furnace area[i] - charge transfer operation	High	Sampling with HiVol sampler[j] and 5-stage impactor[f] from charge inlet to the blast furnace. Charging takes place about 60 times per day.
5	Ore-bin area[k]	High	HiVol sampler[l] and 5-stage impactor[f] in vicinity of ore bins. Ore is high in moisture.
6	Truck-to-rail car transfer area[m]	High	HiVol samplers[n] and 5-stage impactor[f] on overpass dump area and on rail car. Truck level to the north and south of the overpass. Ore is high in moisture. This is an intermittent operation. Ore is dropped from truck beds through grating in overpass into rail cars below.
	Refinery	Low	There were no emissions observed from open and hooded pots used for Zn and Cu removal. No sampling was done at this location.

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[a] Figure 1 and Appendices A and D.
[b] Figures A-2, A-5, A-6, A-8, Appendix A.
[c] Figures C-8, C-9, Appendix C, and Figure D-1, Appendix D.
[d] Figures A-4, A-5, A-9, and A-11, Appendix A.
[e] Figure C-2, Appendix C, and Figure D-1, Appendix D.
[f] Figure C-3, Appendix C, and Figure D-2, Appendix D.
[g] Figures A-2, A-4, A-5, A-13, A-14, and A-16, Appendix A.
[h] Figure C-2, Appendix C, and Figure D-3, Appendix D.
[i] Figures A-2, A-13, and A-14, Appendix A.
[j] Figure C-1, Appendix C, and Figure D-4, Appendix D.
[k] Figures A-5, A-6, and A-15, Appendix A.
[l] Figures C-1 and C-5, Appendix C, and Figures D-4 and D-5, Appendix D.
[m] Figures A-1, A-3, A-18, and A-19, Appendix A.
[n] Figures C-1 and C-5, Appendix C, and Figures D-6, D-7, and D-8, Appendix D.

TABLE 2

SAMPLING LOCATIONS AT EAST HELENA, MONTANA, PLANT

Sampling Location[a] No.	Point	Priority	Remarks
11	Sinter building - roof opening[b]	High	Sinter machine typically has a closed firing bed and gases are drawn to an ESP. Fugitive emissions from the sinter process will rise and leave the building principally through roof and window openings. Sampling with HiVol sampler[c] and 5-stage impactor[d] on roof by a roof opening.[e] Sampling platform,[f] walkway, and safety rail modifications required.
12	Sinter building - collector vent[g]	Medium	There are two nodulizing drums. One has a recycle vent. The other is exausted through roof vent.[h] A HiVol sampler[i] with an auxiliary intake device[j] was used at the roof vent.
13	Sinter building - east, upper-level windows[l]	High	Windows were at a level higher than that of the sinter machine.[k] HiVol samplers[i] and 5-stage impactor[d] were used.
14	Sinter building - east, lower-level windows[n]	High	Windows[m] were at the sinter machine level. HiVol samplers[i] and 5-stage impactor were used.
15	Sinter building - north window[o]	High	Window was near north end of sinter machine and was at level slightly below that of sinter machine. HiVol samplers[i] and 5-stage impactor[d] were used.
16	Sinter building - south window[p]	High	HiVol sampler[i] and 5-stage impactors[d] were used.
17	Dross-kettle and reverbatory-furnace building - above dross operation[q]	High	Vent in roof ran the length of the building along roof center line.[r] Dross generation in one-half of building, reverbatory-furnace operations in other.[r] There were continuous emissions from open kettles. HiVol air samplers[i] and 5-stage impactors[d] were used. Exterior site modifications were needed for sampling at this building.
18	Dross-kettle and reverbatory-furnace building - above reverbatory operation[q]	High	Needs and setup similar to that of Location 17 except samplers were located above the reverbatory operation.[s]
19	Blast furnace - open roof area above charge inlet point[t]	High	There are considerable emissions when the furnace bridges over, and this bridge is released with the aid of dynamite. The emissions are exhausted to the atmosphere through roof and side opening. The frequency and time of the blow out are not known. Special sampling platforms and structures are needed. HiVol sampler[i] and 5-stage impactor[d] used.
20	Blast furnace - exhaust stack[u]	High	Hoods are over lead and slag pots. These hoods are ducted to roof exhaust stack. Continuous operations. HiVol sampler with auxiliary intake[j] and 5-stage impactor[d] were used.
21	Zinc-fume baghouse - rail car loading area[v]	Low	Rail cars are loaded under cover from the baghouse. Zinc fume reportedly has 9-10% lead content. The zinc fume in the uncovered rail cars is sprayed with water latex emulsion to keep loss minimized during transport. Fume in covered rail cars is not sprayed.

TABLE 2 (Concluded)

Sampling Location[a]			
No.	Point	Priority	Remarks
22	Zinc-fume baghouse - old rail car loading area[w]	Low	HiVol sampler[i] at ground level. This is a tunnel-like area under the zinc-fume condensers that used to be utilized as the rail car loading area.
23	Zinc furnace - exhaust area[x]	Low	This is a batch operation of approximately 2.5 hr cycle time. The fume emissions are from roof opening and side openings. The emissions reportedly contain very little lead. HiVol sampler[i] and a 5-stage impactor[d] were used in roof opening and one was outside building at ground level.
24	Unloading/outdoor bins[y]	Low	Rail cars of incoming ore are unloaded by backhoe. The ore is put into open bins. It remains there for relatively short periods of time as it is conveyed under cover to internal storage bins. Unloading takes place for approximately 40 hr/week. A HiVol sampler[i] and 5-stage impactor[d] were used at the north side of the bins and to the south side of the bins.
	Internal storage and feeder	Low	These were very well covered storage bins. A well-enclosed auger system transported material to the process building which was open at one end. The ventilation system fed to a baghouse. No sampling was done here.

---

[a] Figure 2 and Appendices B and E.
[b] Figures B-3, B-4, B-5, and B-6, Appendix B.
[c] Figure C-2, Appendix C.
[d] Figure C-3, Appendix C.
[e] Figure B-3, Appendix B, and Figures E-1 and E-2, Appendix E.
[f] Figure B-3, Appendix B.
[g] Figures B-2 to B-6, Appendix B, and Figures E-1 to E-3, Appendix E.
[h] Figures B-3, B-5, and B-6, Appendix B, and Figures E-1 and E-2, Appendix E.
[i] Figure C-1, Appendix C.
[j] Figures C-4, Appendix C.
[k] Figure B-2, Appendix B, and Figure E-1, Appendix E.
[l] Figure B-2, Appendix B, and Figure E-1, Appendix E.
[m] Figure E-2, Appendix E.
[n] Figures B-2 and B-6, Appendix B, and Figure E-2, Appendix E.
[o] Figures B-3, B-5, and B-6, Appendix B.
[p] Figures B-3, B-4, and B-6, Appendix B.
[q] Figures B-1, B-9, B-10, and B-11, Appendix B, and Figure E-4, Appendix E.
[r] Figures B-9 and B-10, Appendix B, and Figures E-3 and E-4, Appendix E.
[s] Figure B-10, Appendix B, and Figure E-4, Appendix E.
[t] Figures B-12, B-13, and B-15, Appendix B, and Figure E-5, Appendix E.
[u] Figures B-12, B-14, and B-15, Appendix B, and Figure E-5, Appendix E.
[v] Figures B-16, B-17, and B-18, Appendix B, and Figures E-7 and E-8, Appendix E.
[w] Figure B-18, Appendix B, and Figure E-6, Appendix E.
[x] Figures B-19, B-20, B-21, and B-22, Appendix B, and Figure E-9, Appendix E.
[y] Figure B-1, Appendix B, and Figure E-10, Appendix E.

II. SUMMARY OF TEST RESULTS

The results of field sampling and laboratory analysis of samples are summarized in five tables (Tables 3 through 7 which are located at the end of the text of this report, pages 80 to 111). Each table consists of information from both ASARCO plants at which sampling was conducted. The first seven columns of each table contain the sampling data. Runs 1 through 12 were performed at the Glover, Missouri, plant, and Runs 20 through 33 were performed at the East Helena, Montana, plant. (There were no Runs 13 through 19.) Footnotes on the tables help clarify the data.

Table 3 contains sampling and climatic data. The sampling data are run number, sampling location, date and time of run, sampling period, sample set, sample type, filter number, particle-size ranges (for Sierra impaction samples), sampler flow rate, fugitive source flow rate and effective area, and the volume of air sampled under both actual and standard conditions. The climatic data cover wind velocity, wind direction, temperature, and barometric pressure. In some locations, MRI had its own wind velocity and wind direction equipment. In these cases, MRI's measurements were used, because the instruments were closer to the specific sampling sites than were the ASARCO meteorological stations. Footnote "g" of Table 3 explains which data are MRI's and which are ASARCO's.

The set and type of samples specified in Columns 6 and 7 of Table 3 are defined in Footnote "c" of the table. Further discussion is given in Section VI-A.

Particulate-size ranges are a function of the specific flow rate at which a sampler with the 5-stage Sierra impactor was operated and the specific gravity and physical shape of the particulate. The ranges given in Column 9 of Table 3 are based upon 50% collection efficiency for spherical particles of specific gravity 2.5 and are adjusted for flow rate.

The air flow data given in Column 11 of Table 3 are the velocities of the fugitive emission streams.

The effective area given in Column 12 of Table 3 is that area through which the fugitive emissions flow. This area is adjusted to compensate for the particulate distribution profiles within an area.

The climatic conditions comprise wind velocity, wind direction, ambient temperature, and barometric pressure. The temperature and barometric data given in the last two columns of Table 3 are measurements from the plants' weather stations. All wind velocity and wind direction data (Columns 15 and 16, respectively, of Table 3) are from MRI field meteorological stations unless otherwise noted in the table.

The total mass (in grams) of each sample is given in Column 9 of Table 4. The weights of three elements--Pb, As, and Cd--identified in some of the samples are also given in Columns 10 through 12, respectively. Density values were determined for only a limited number of samples. These density values are given in Column 13 of Table 3.

Table 5 gives the total particulate concentrations (in micrograms per cubic meter) of each sample for both actual conditions and standard conditions (77°F and 29.92 in. Hg) in Columns 9 and 10, respectively. The concentrations (in micrograms per cubic meter) under actual and standard conditions of Pb, As, and Cd in some of the samples are given in the remaining columns of Table 5. Locations 4A, 5A, 6, 6N, 6S, 23A, 24N, and 24S provided only ambient-air background concentrations. Although all concentrations are given in three figures, it must be recognized that the accuracy of fugitive sampling sources, as those of this test, is dependent upon numerous uncontrollable factors such as those stated in Paragraph 3 of this section.

Table 6 is a tabulation of total particulate Pb, As, and Cd emission rates in milligrams per minute under both actual and standard conditions. Since Locations 4A, 5A, 6, 6N, 6S, 23A, 24N, and 24S provided only ambient-air background concentrations, no emission rates were calculated for these locations. All emission rates are given in three significant figures, since calculations involving climatic conditions, velometer measurements, and effective areas do not permit any greater accuracy.

Some of the field samples were analyzed for lead and arsenic species. Some of these samples were analyzed by electron spectroscopy for chemical analysis (ESCA), and the others were analyzed by X-ray diffraction. The species identified are given in Columns 9 through 22 of Table 7. Those analyzed by ESCA were samples of Set 3 (Column 6). Those analyzed by X-ray diffraction were samples of Set 4 (Column 6).

Information on emission rates of total particulate, lead, and arsenic, lead content by particle-size range, chemical species and particle density for each plant is presented next. A comparison of these results for the two plants is discussed in the last part of this section.

A. ASARCO Plant, Glover, Missouri

This subsection summarizes the results of the sampling tests that were performed at the ASARCO plant located in Glover, Missouri. The following types of information are presented: total particulate mass emission rate, total emission rate of both lead and arsenic, lead content by particle-size range, chemical species containing the lead, and particle density.

1. Fugitive emission rate: total particulate, lead, and arsenic: The emission rates are summarized in Table 8 for the sinter building (Sampling Locations 1-top, 1-bottom, 2-north, and 2-south), the blast-furnace and dross-kettle areas (Sampling Locations 3, 3A, and 4), and the ore-storage-bin area (Sampling Location 5). A summation of the emission rates of these three areas, which represents the total fugitive emission of particulate from the plant, is also presented. The other sampling locations--6-overpass, 6-north, and 6-south at the ore truck-to-railcar transfer point, and Locations 4A and 5A--were not included, since these sites provided only ambient-air background concentrations. The justification for eliminating these locations is given in Section VI-C-6, where the emission calculations for a location are also given and discussed.

At those locations for which emission rates were calculated (Locations 1-top, 1-bottom, 1, 2N, 2S, 3, 3A, 4, and 5), the data from some of the runs made at these locations were not used in calculating the average emission rates of total particulates, lead, and arsenic. The principal reason for excluding some data is wind direction (blowing into the building at the sampler location), and, in the cases for lead and arsenic, an additional reason is that there were no data available. Table 9 identifies the runs for which the concentration values were (and were not) used in determining average emission rates. Appendix N contains the calculations of emission rates and also gives the justification for eliminating concentration data.

Representative average emission rates in Table 8 are given in kilograms per hour (kg/hr), kilograms per day (kg/day), pounds per hour (lb/hr), and pounds per day (lb/day). The plant's total fugitive particulate rate is 253 lb/day. The sinter building and the blast-furnace/dross-kettle area are the highest with 122 and 123 lb/day emissions of total particulates, which accounts for 48.2 and 48.6%, respectively, of the plant's fugitive, total particulate emissions. The third area, ore-storage bins, emitted 8.25 lb/day total particulate emissions, which is only 3.2% of the fugitive emissions.

Lead fugitive emissions for the sinter building and the blast-furnace/dross-kettle area are 42.2 and 62.8 lb/day, respectively. These emissions represent 38.8 and 57.7%, respectively, of the total fugitive lead emissions from the plant.

The arsenic emissions are low by comparison with either total particulate or lead emissions. These were 0.04 and 0.21 lb/day emissions of arsenic, respectively, from the sinter building and the blast-furnace/dross-kettle area. Arsenic from the ore-storage-bin area was insignificant, < 0.01 lb/day.

TABLE 8

GLOVER, MISSOURI, PLANT FUGITIVE EMISSION RATE:[a] TOTAL PARTICULATE, LEAD AND ARSENIC

	Total Particulate[a]					Lead[a]					Arsenic[a]				
Operations	kg/hr	kg/day	lb/hr	lb/day	% of Total	kg/hr	kg/day	lb/hr	lb/day	% of Total	kg/hr	kg/day	lb/hr	lb/day	% of Total
Sinter-bldg.	2.30	55.2	5.07	122	48.2	0.80	19.2	1.76	42.2	38.8	<0.01	0.02	<0.01	0.04	16
Blast-furnace	2.33	55.9	5.13	123	48.6	1.19	28.5	2.62	62.8	57.7	<0.01	0.10	0.01	0.21	84
Ore-storage bins	0.16	3.74	0.34	8.25	3.2	0.07	1.74	0.16	3.84	3.5	<0.01	<0.01	<0.01	<0.01	-
Glover, Mo. Plant	4.79	115	10.5	253		2.06	49.4	4.54	109		<0.01	0.12	0.01	0.25	

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[a] All results are given to only three significant figures.

TABLE 9

RUNS AT GLOVER, MISSOURI, PLANT FOR WHICH CONCENTRATION DATA WERE USED TO DETERMINE AVERAGE EMISSION RATES

	Runs					
	Used			Not Used		
Location	Total Particulates	Pb	As	Total Particulates	Pb	As
1T	1,3,5	1,3	1,3	2	2,5	2,5
1B	1,3,5	3	3	2	1,2,5	1,2,5
1	1,3,5	-	-	2	1,2,3,5	1,2,3,5
2N	1-5	1,2,3	1,2,3	-	4,5	4,5
2S	1-5	1,2,4,5	1,2,4,5	-	3	3
3	2,3,4	3,4	3,4	1,5	1,2,5	1,2,5
3A	3,5	3,5	3,5	1,2,4	1,2,4	1,2,4
4	6-11	-	-	-	6,11	6,11
4A	None[a]	None[a]	None[a]	[a]	[a]	[a]
5	2,9	9	9	6,8,10	6-8,10	6-8,10
5A	None[a]	None[a]	None[a]	[a]	[a]	[a]
6	None[b]	None[b]	None[b]	[b]	[b]	[b]
6N	None[b]	None[b]	None[b]	[b]	[b]	[b]
6S	None[b]	None[b]	None[b]	[b]	[b]	[b]

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[a] There was only one run (No. 12) and this was not used for emissions because wind was directed into the building. Thus, it gave only ambient background concentrations of total particulate. This value is 270 $\mu g/m^3$ for standard conditions.

[b] Because of the location of the samples, wind conditions, the fact that there were no visual emissions, and the ore had a high moisture content (~ 15%), these gave only ambient background concentrations. These values were generally between 80 and 400 $\mu g/m^3$. There were two exceptions, 854 and 3,080 $\mu g/m^3$, which are believed due to micrometeorological conditions.

The emission rates given in Table 8 were obtained from a limited sampling program of short duration and do not reflect all operating and weather conditions. Moreover, there were assumptions made on the particle distribution profiles at each fugitive source sampled. (See Section VI-C and Appendix M.) Therefore, the results given cannot be taken as absolute, but rather as representative.

The ratio of lead-to-total particulate is given in Table 10. The lead-to-total particulate ratios of 0.508 and 0.498 are greatest for the ore-storage-bin area and the blast-furnace areas, respectively. The next highest ratio, 0.275, was for the sinter building. The lowest ratio was 0.104, which was background* measured at the ore, truck-to-rail transfer point.

TABLE 10

LEAD-TO-TOTAL PARTICULATE RATIO: GLOVER, MISSOURI, PLANT

Operation	Lead/Total Particulate
Ore-storage-bin area	0.508
Blast-furnace area	0.498
Sinter building	0.275
Background[a]	0.104

[a] At ore, truck-to-rail transfer point.

2. Lead content by particle-size range: The particle-size range of total particulate fugitive emissions was determined for four locations: sinter building, blast-furnace area (tapping operations), blast-furnace area (charge-feed operations), and ore-storage-bin area. The Sierra, Model 230, HiVol cascade impactor was used for these measurements. This 5-stage impactor with a back-up filter provides the following size ranges in microns at 50% collection efficiency for spherical particles of specific gravity of 2.5, when the sampler is operated at a flow rate of 40 scfm:

Back-up filter	< 0.31
Stage 5	0.31-0.59
Stage 4	0.59-0.95

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* Background is the particulate concentration in the ambient air that is not contributed to by the particular source of fugitive emission being sampled.

Stage 3	0.95-1.9
Stage 2	1.9-4.6
Stage 1	> 4.6

The lead content by particle-size ranges, adjusted for the variation of the flow rate of the sampler, is given in tabular form in Table 11 and in graphic form in Figure 3. There are two different means by which the lead content is represented in Table 11 and Figure 3. One is the lead portion of the sample in micrograms per cubic meter, and the other is the ratio of lead-to-total particulate.

At the sinter building the lead concentration (micrograms per cubic meter) generally decreases with an increase in the aerodynamic size range of the particulate. For the fine particulate (< 0.38 μ), the lead concentration was 826 μg/m^3. This value decreased rapidly to 120 μg/m^3 for particulate between 0.38 and 0.71 μ and 101 μg/m^3 for the size range 0.71 to 1.15 μ. The lead concentration then fell to a value of approximately 67 μg/m^3 for the sizes greater than 1.15 μ. The ratio of lead-to-total particulate remained constant at 0.581 throughout all ranges. These results seem to indicate that the material is of a fixed chemical composition and contains relatively few compounds.

Walter C. McCrone Associates, Inc., performed a particle-size analysis on 10 samples: two from Location 1, which is the north end of the sinter building; and the other eight were from samples taken at East Helena and are therefore reported in Section II-B-2. The results of this analysis for the two samples (Nos. 3004 and 3006) from Location 1 are given below by eight different size distribution groups in both number percent and calculated weight percent.

Size (μ)	Number Percent		Calculated Weight Percent	
	3004[a]	3006[a]	3004[a]	3006[a]
< 5	83.1	52.5	7.2	1.2
5-10	12.5	31.7	16.9	11.3
10-15	2.4	9.1	14.9	15.0
15-20	1.3	4.4	22.4	19.7
20-25	0.5	0.9	18.2	8.7
25-30	0.1	0.8	6.7	14.1
30-40	0.1	0.4	13.7	14.5
40-50	-	0.2	-	15.5
50+				

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[a] Sample numbers.

TABLE 11

LEAD CONTENT BY PARTICLE-SIZE RANGE: GLOVER, MISSOURI, PLANT

	Concentration ($\mu g/m^3$)			Particle-Size Range[b]
Location	T.P.[a]	Lead	Ratio (Lead/T.P.)	(μ)
Sinter building	1,420	826	0.581	< 0.38
	207	120	0.580	0.38-0.71
	174	101	0.580	0.71-1.15
	112	65.1	0.581	1.15-2.3
	117	68.1	0.582	2.3-5.6
	116	67.5	0.581	> 5.6
Blast furnace (tapping operations)	44.1	27.5	0.625	< 0.31
	39	16.6	0.425	0.31-0.59
	32.7	15.0	0.459	0.59-0.95
	24.7	12.5	0.506	0.95-1.9
	40.4	22.5	0.557	1.9-4.6
	75.7	45	0.594	> 4.6
Blast furnace (charge-feed area)	1,301	897	0.689	< 0.33
	79.1	42.9	0.542	0.33-0.63
	82.1	40.7	0.496	0.63-1.0
	81.2	48.3	0.595	1.0-2.03
	190	107	0.563	2.03-4.9
	338	182	0.538	> 4.9
Ore-storage-bin area	372	80	0.215	< 0.31
	36.6	7.89	0.215	0.31-0.59
	54.4	11.7	0.215	0.59-0.95
	45.1	9.71	0.215	0.95-1.9
	89.5	19.3	0.216	1.9-4.6
	177	38	0.215	> 4.6

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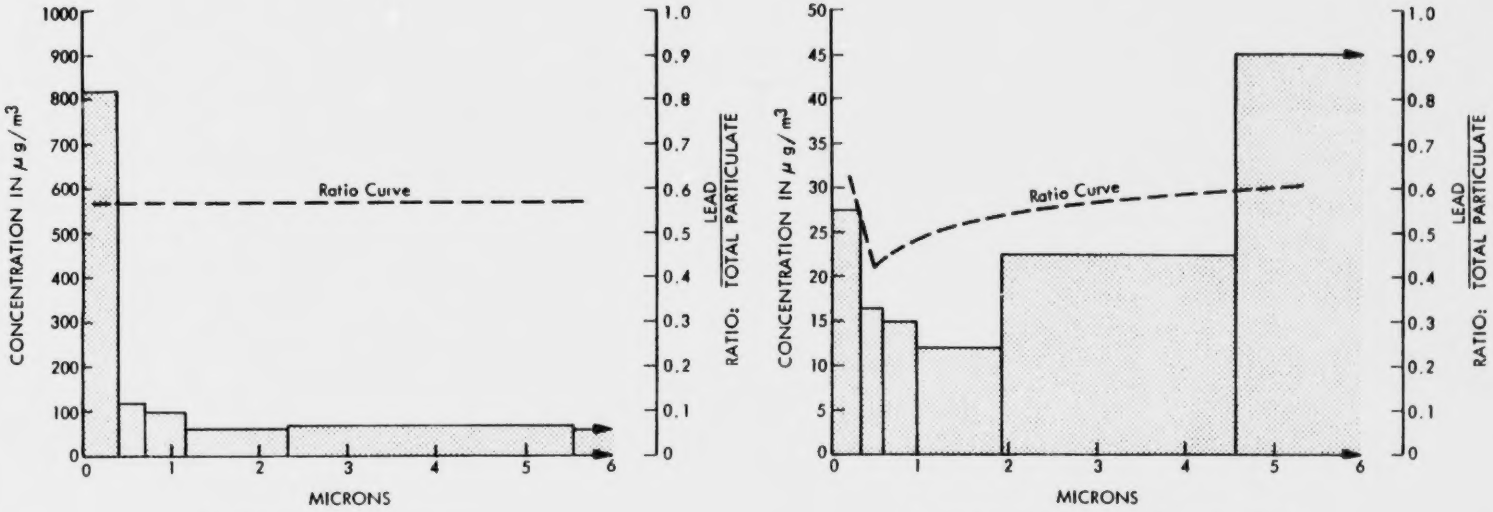
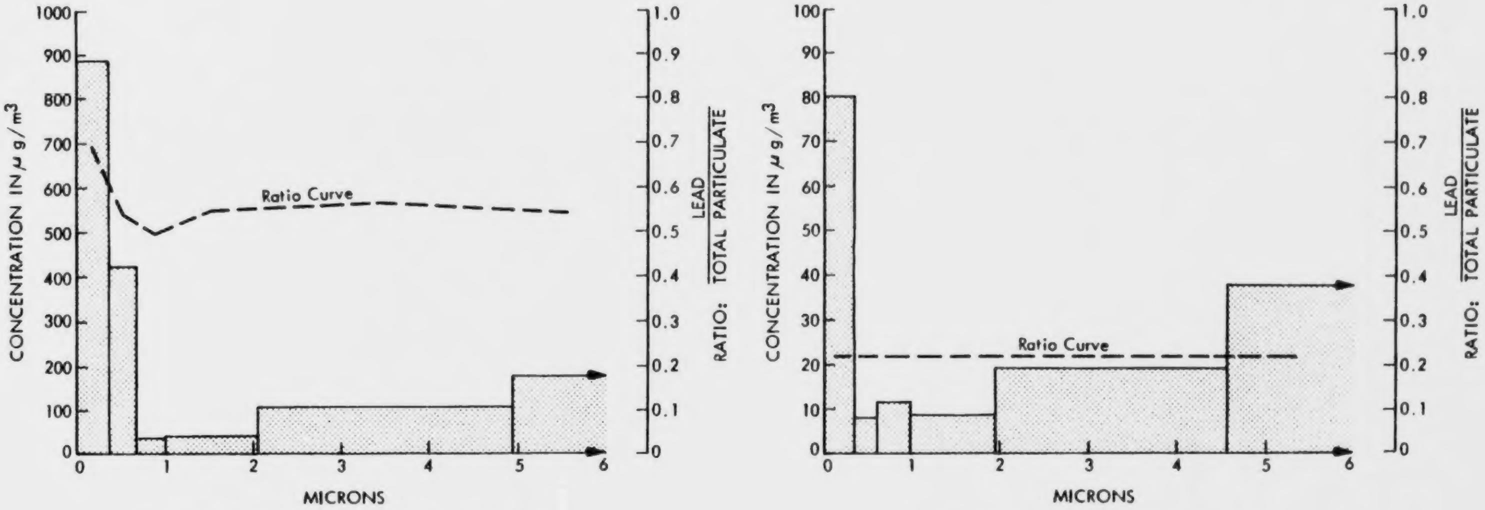
[a] T.P. = total particulate.

[b] Aerodynamic particle size (Sierra 5-stage impactor was used in HiVol samples).



(a) Sinter Building - Location 2 N

(b) Blast Furnace Tapping Operation: Location 3



(c) Blast Furnace (Charge-Feed Area): Location 4

(d) Ore-Storage-Bin Area: Location 5

Figure 3 - Lead Content by Particle Size Showing Lead Concentration in μg/m^3 and Lead-to-Total Particulate Ratio: Glover, Missouri, Plant

The blast-furnace tapping operations area gave more variable results. The concentration was relatively high (27.5 $\mu g/m^3$) for the fine particulate (< 0.49 μ), decreasing to 12.5 $\mu g/m^3$ in the size range of 0.95 to 1.9 μ, and then increasing to 45 $\mu g/m^3$ for sizes > 1.9 μ. The ratio of lead-to-total particulate was variable also. It was greatest at 0.625 for particulate < 0.31 μ, dipped to a low of 0.425 for the size range 0.31 to 0.59 μ, and then increased to 0.594 for particulate size > 0.59 μ. These results suggest the presence of a variety of molten lead compounds.

The charge-feed area of the blast-furnace operations gave results like the sinter building operations. However, in this case, the ratio curve is not linear at the lower size ranges.

The lead concentration in micrograms per cubic meter for the ore-storage-bin area is very nearly the same as that for the blast-furnace tapping operations area. However, the ratio curve is constant at 0.215. The results indicate that the material is of fixed composition.

3. Chemical species: The results of the chemical species analysis are given in Table 7. These results are summarized in Table 12 and show, by operational area at the plant, lead and arsenic species as well as other species. These results are from the analysis of only a portion of the samples.

4. Particle density: The particle density results are given in Table 4 by sampling location. These results are summarized in Table 13 by operational areas. The results are from one sample only in each case, except for the sinter building area. The particulates from the ore-storage-bin area had the highest density of 3.67 g/cm^3. The next highest was the blast-furnace, charge-feed area with 3.25 g/cm^3. The sinter building was 2.76 g/cm^3, which is an average of four values that ranged from 2.54 to 3.3 g/cm^3. The particulate from the blast-furnace area (tapping operations) had a value of 2.04 g/cm^3. The background was 1.2 g/cm^3.

B. ASARCO Plant, East Helena, Montana

This subsection summarizes the results of the sampling tests that were performed at the ASARCO plant located in East Helena, Montana. The following types of information are presented: total particulate mass emission rate, total emission rate of both lead and arsenic, lead content by particle-size range, chemical species containing lead, and particle density.

TABLE 12

CHEMICAL SPECIES IN THE PARTICULATE FUGITIVE EMISSIONS AT THE GLOVER, MISSOURI, PLANT

	Species										
Operational Area	ZnO	ZnS	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate	Sulfide	Comment
Sinter-building	X	X			X	X	X	X	X	X	Chlorite present
Blast-furnace (tapping operation)		X		X	X		X	X	X		Trace of PbO_2
Blast-furnace (charge-feed)		X			X		X	X	X	X	
Ore-storage-bins		X			X		X	X	X	X	
Background[a/]		X	X		X	X	X	X	X	X	Chlorite present

[a/] From Locations 4A, 5A, 6N, and 6S.

TABLE 13

PARTICLE DENSITY: GLOVER, MISSOURI, PLANT

Operational Area	Density (g/cm^3)
Ore-storage-bin area	3.67
Blast furnace (charge-feed area)	3.25
Sinter building	2.76 (avg.)[a]
Blast furnace (tapping area)	2.04
Background	1.2

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[a] The range from the four samples whose average is 2.76 g/cm^3 is 2.54 to 3.3 g/cm^3.

1. Fugitive emission rate: total particulate, lead, and arsenic: The emission rates are summarized in Table 14 for the sinter building (Sampling Locations 11 through 16), the dross/reverberatory building (Sampling Locations 17 and 18), blast furnace (Sampling Locations 19 and 20), zinc-fuming facility (Sampling Locations 21 and 22) and zinc furnace (Sampling Location 23), as well as the summation of these areas which represent the total fugitive emissions of particulate from the plant. The other Sampling Locations 23A (ground level in the vicinity of the zinc furnace) and 24N and 24S (ore loading) were not included since they provided only background particulate concentrations. The justification for eliminating these locations is given in Section VI-C-6, where the emission calculations (Appendix N) for a location are also recorded and discussed.

At those locations for which emission rates were calculated (Locations 11 to 23), the data from some of the runs made at these locations were not used in calculating the average emission rates of total particulates, lead, and arsenic. Table 15 identifies the runs for which run data were not used in calculating average lead and arsenic emission rates. The reason for not including the runs is that there were no concentration values available. Appendix N contains the calculations of emission rates.

Representative average emission rates in Table 14 are given in kilograms per hour, kilograms per day, pounds per hour, and pounds per day. The plant's total fugitive emission rate is 447 lb/day. The dross/reverberatory building had the highest total particulate emission rate of 300 lb/day or 67.1% for the plant total. The sinter building is next with 64.8

TABLE 14

EAST HELENA, MONTANA: PLANT FUGITIVE EMISSION RATE:[a] TOTAL PARTICULATE, LEAD AND ARSENIC

	Total Particulate[a]					Lead[a]					Arsenic[a]				
Operations	Kg/Hr	Kg/Day	Lb/Hr	Lb/Day	% of Total	Kg/Hr	Kg/Day	Lb/Hr	Lb/Day	% of Total	Kg/Hr	Kg/Day	Lb/Hr	Lb/Day	% of Total
Sinter-building	1.22	29.4	2.70	64.8	14.5	0.12	2.84	0.26	6.25	7.7	0.10	0.23	0.02	0.51	1.6
Dross/reverberatory building	5.66	136.0	12.5	300.0	67.1	1.26	30.2	2.78	66.7	82.0	0.57	13.8	1.26	30.3	96.2
Blast-furnace	0.66	15.8	1.46	34.9	7.8	0.07	1.71	0.16	3.78	4.6	0.01	0.25	0.02	0.55	1.7
Zinc-fuming facility	0.26	6.34	0.58	14.0	3.1	0.03	0.68	0.06	1.49	1.8	< 0.01	0.02	< 0.01	0.06	0.2
Zinc-furnace	0.64	15.3	1.40	33.6	7.5	0.06	1.45	0.13	3.21	3.9	< 0.01	0.05	< 0.01	0.11	0.3
East Helena, Montana plant	8.44	203	18.6	447		1.54	36.9	3.39	81.4		1.20	14.4	1.30	31.5	

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a/ All results are given to only three significant figures.

TABLE 15

RUNS AT EAST HELENA, MONTANA, PLANT FOR WHICH CONCENTRATION DATA WERE USED TO DETERMINE AVERAGE EMISSION RATES

	Runs					
	Used			Not Used		
Location	T.P.	Pb	As	T.P.	Pb	As
11	20-22	20	20	-	21,22	21,22
12	20-22	20,22	20,22	-	21	21
13	20-22	20,22	20,22	-	21	21
14	20,21[a]	20	20	[a]	21	21
14A	22[a]	22	22	[a]	-	-
15	20-22	20,22	20,22	-	21	21
16	20-22	20,22	20,22	-	21	21
17	27-33	27,30,32,33	27,30,32,33	-	28,29,31	-
18	27-33	27,32,33	27,32,33	-	28-31	28-31
19	28,29,30-33	29,30,32,33	29,30,32,33	-	28	28
20	28,29,30-33	29,30,32	29,30,32	-	28,33	28,33
21	23,25	25	25	-	23	23
22	23,25	25	25	-	23	23
23	23-27	24,25,27	24,25,27	-	23,26	23,26
23A	None[b]	None[b]	None[b]	[b]	[b]	[b]
24N	None[c]	None[c]	None[c]	[c]	[c]	[c]
24S	None[c]	None[c]	None[c]	[c]	[c]	[c]

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[a] There were only two runs for Location 14 and one run for Location 14A.

[b] This was a background sampler and thus only concentration is applicable. These concentration values ranged from 1,230 to 3,890 $\mu g/m^3$.

[c] Because of the wind direction, the concentrations measured provide only particulate background data. The background concentrations ranged between 2,380 and 4,870 $\mu g/m^3$ at these locations.

lb/day or 14.5%. The blast-furnace and zinc-furnace operations were essentially the same at 34.9 and 33.6 lb/day, respectively, which were 7.8 and 7.5% of the plant total, respectively. The zinc-fuming operation was least, with 14.0 lb/day or 3.1% of the plant total.

The lead fugitive emission rates followed the same general pattern, with the dross/reverberatory operation having the highest lead emission rate, 66.7 lb/day, or 82% of the plant total of 81.4 lb/day. The sinter building was next with 6.25 lb/day or 7.7% of the plant total. The blast furnace and zinc furnace were about the same with 3.78 and 3.21 lb/day, respectively, or 4.6 and 3.9%, respectively. The zinc-fuming operation is lowest with 1.49 lb/day or 1.8% of the plant total fugitive lead emission rate.

The arsenic fugitive emission rates were generally low. The highest was 30.3 lb/day from the dross/reverberatory operation, or 96.2% of the plant total of 31.5 lb/day. The blast furnace and sinter building operations were next highest with 0.55 and 0.51 lb/day, respectively, or 1.7 and 1.6% of the plant total, respectively. The zinc furnace and zinc fuming operations were least with 0.11 and 0.06 lb/day, respectively, or 0.3 and 0.2% of the plant total, respectively.

The emission rates given in Table 14 were obtained from a limited sampling of short duration, and do not reflect all operating and weather conditions. Moreover, there were assumptions made on the particle distribution profiles at each fugitive source sampled. (See Section VI-C and Appendix M.) Therefore, the results given cannot be taken as absolute, but rather are representative.

The ratio of lead-to-total particulate is given in Table 16. Both the highest and lowest values were of ambient-air background. The highest, a value of 0.217, was at the incoming ore loading area; and the lowest, a value of 0.019, was near the zinc-furnace building. The second highest ratio is 0.222, which was from the dross/reverberatory operations. The other four operations, zinc furnace, sinter building, zinc fuming, and blast furnace, were all nearly the same, with ratios of 0.095, 0.096, 0.108, and 0.108.

2. Lead content by particle-size range: The particle-size range of total fugitive emissions was determined for the blast-furnace operations. The Sierra Model 230 HiVol cascade impactor was used for these measurements.

TABLE 16

LEAD-TO-TOTAL PARTICULATE RATIO: EAST HELENA, MONTANA, PLANT

Operational Area	Lead/Total Particulate
Background	
Ore loading	0.217
Zinc furnace area	0.019
Dross/reverberatory building	0.222
Zinc furnace	0.095
Sinter building	0.096
Zinc fuming facility	0.108
Blast furnace	0.108

This 5-stage impactor with a back-up filter provides the following size range in microns at 50% collection efficiency for spherical particles of specific gravity 2.5, when the sampler is operated at a flow rate of 40 scfm:

Back-up filter	< 0.31
Stage 5	0.31-0.59
Stage 4	0.59-0.95
Stage 3	0.95-1.9
Stage 2	1.9-4.6
Stage 1	> 4.6

The lead content by particle-size ranges is given both in tabular form and graphic form in Figure 4. There are two different ways in which the lead content is represented in Figure 4. One is the lead portion of the sample in micrograms per cubic meter and the other is the ratio of lead-to-total particulate.

The lead concentration, as measured at the blast-furnace roof opening (Location 19), varied from 30.8 $\mu g/m^3$ for the finer particulate (< 0.31) to 9.03 $\mu g/m^3$ for particulates between 1.9 and 4.6 μ. The ratio of lead-to-total particulate over the particle-size ranges varied from 0.038 to 0.149.

Walter C. McCrone Associates, Inc., performed a particle size analysis on 10 samples, eight of which (Samples Nos. 3042, 3047, 3052, 3062, 3067, 3077, 3082, and 3087) were from sampling at East Helena, Montana. The results of this analysis are given below in nine different size distribution groups in both number and calculated weight percent.

Concentration[1] in $\mu g/m^3$			
Total Particulate	Lead	Ratio Lead/T.P.	Particle Size Range in Microns
652.0	30.8	0.047	<0.31
375.0	14.3	0.038	0.31 - 0.59
242.0	18.9	0.078	0.59 - 0.95
132.0	12.1	0.092	0.95 - 1.9
102.0	9.03	0.088	1.9 - 4.6
71.1	10.6	0.149	>4.6

[1] Measured at Blast Furnace Roof Opening: Location 19

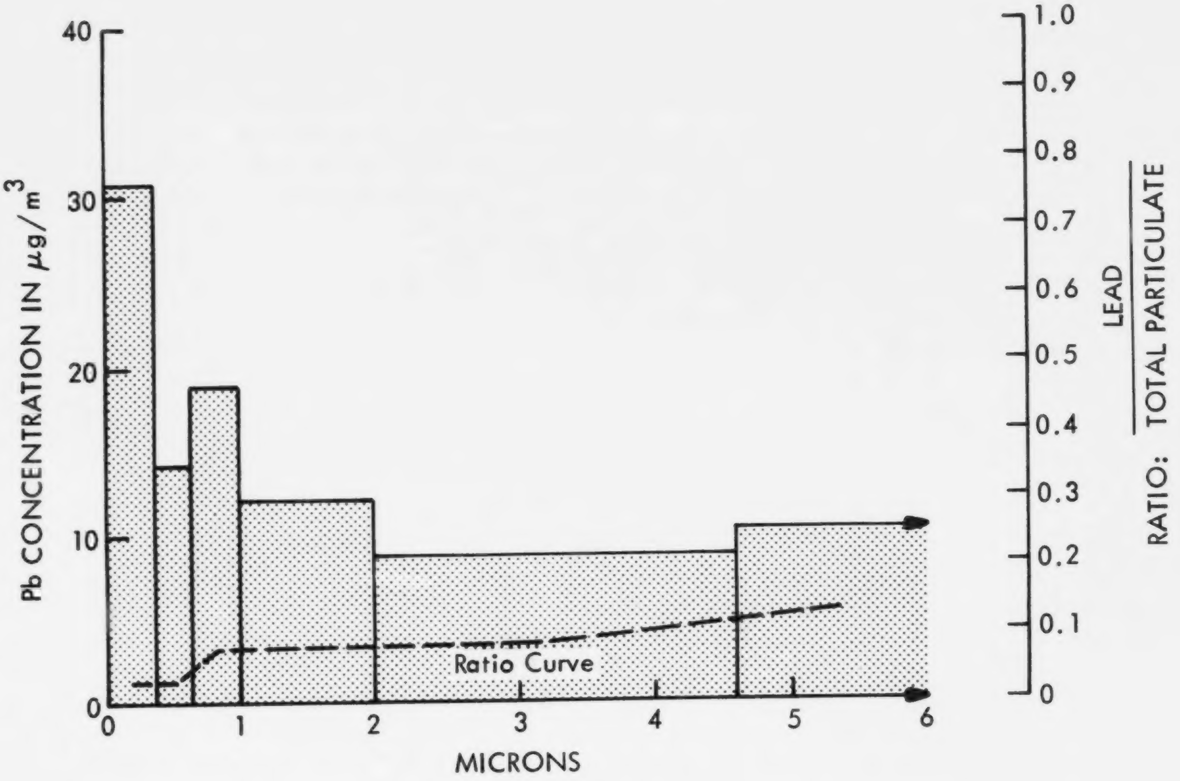


Figure 4 - Lead Content by Particle Size Showing Lead Concentration in $\mu g/m^3$ and Lead-to-Total Particulate Ratio: East Helena, Montana, Plant

Particle-Size Distribution in Number Percent

Size	Sinter Building		Dross Kettles		Reverberatory Furnace		Blast Furnace	Zinc Furnace
(μ)	3042	3047	3082	3062	3067	3077	3087	3052
< 5	63.1	72.5	72.3	65.3	57.2	72.2	68.7	72.7
5-10	29.0	21.4	22.7	23.2	30.2	20.2	20.0	18.2
10-15	5.0	4.0	3.7	6.2	7.8	4.7	5.4	5.8
15-20	1.9	1.5	1.1	3.2	2.9	1.7	3.3	2.2
20-25	0.5	0.3	0.1	1.1	0.8	0.6	1.2	0.6
25-30	0.4	0.2	0.1	0.5	0.7	0.4	0.6	0.2
30-40	0.1	0.1	-	0.4	0.4	0.2	0.5	0.2
40-50	-	-	-	0.1	-	-	0.2	0.1
50+	-	-	-	-	-	-	0.1	-

Particle-Size Distribution in Calculated Weight Percent

Size	Sinter Building		Dross Kettles		Reverberatory Furnace		Blast Furnace	Zinc Furnace
(μ)	3042	3047	3082	3062	3067	3077	3087	3052
< 5	3.3	5.1	7.0	2.0	1.8	3.7	1.5	3.2
5-10	23.4	23.4	34.5	10.9	14.9	16.3	7.0	12.5
10-15	18.7	20.1	25.9	13.4	17.8	17.5	8.8	18.4
15-20	19.5	20.8	21.1	19.0	18.0	17.4	14.6	19.2
20-25	10.9	8.8	4.1	13.9	10.6	13.0	11.3	11.1
25-30	16.0	10.7	7.4	11.6	17.0	15.8	10.3	6.8
30-40	8.2	11.1	-	19.1	19.9	16.3	17.7	14.0
40-50	-	-	-	10.1	-	-	15.1	14.8
50+	-	-	-	-	-	-	13.7	-

3. Chemical species: The results of the chemical species analysis are given in Table 7. These results are summarized in Table 17 and are shown by operational area at the plant, lead and arsenic species as well as other species. These results are from the analysis of only a portion of the samples. Since we did not sample in the vicinity of where the lead ingots are poured, and the sources we did sample were hot high temperatures, it is very likely that analysis of samples would not show metallic lead, such as the data in Appendix K.

4. Particle density: The particle density results are given in Table 4 by sampling location. These results are summarized in Table 18 by operational areas.

TABLE 17

CHEMICAL SPECIES IN THE PARTICULATE FUGITIVE EMISSIONS AT THE EAST HELENA PLANT

Operational Area	ZnO	ZnS	$CaCO_3$	As_2CO_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbS	$PbSO_4$	Sulfate	Sulfide
Sinter-building	X	X			X		X	X	X	X	X	X	X
Dross-kettles	X	X		X			X	X	X	X	X	X	
Reverberatory-furnace	X	X						X		X	X		
Blast-furnace	X	X				X	X	X		X	X		
Zinc-fuming facility	X	X	X							X	X		
Zinc-furnace	X	X						X		X	X		
Background	X	X		X						X	X		

TABLE 18

PARTICLE DENSITY: EAST HELENA, MONTANA, PLANT

Operational Area	Density (g/cm^3)
Dross-kettles	3.27
Reverberatory-furnace	2.62
Blast-furnace	2.16[a/]
Sinter-building	1.72[b/]
Zinc-furnace	1.54
Background	1.08

[a/] An average of two sample densities--1.92 and 2.40 g/cm^3.

[b/] An average of three sample densities--2.18, 1.53, and 1.46 g/cm^3.

The results given are from one sample only in each case, except for the dross kettles where there were two samples and the sinter building where there were three samples. The particulates from the dross kettles had the highest density of 3.27 g/cm^3. The reverberatory furnace was next highest with 2.62 g/cm^3. The blast-furnace particulate had an average density of 2.16 g/cm^3, which was the average of 1.92 and 2.40 g/cm^3. The sinter building particulate density of 1.72 g/cm^3 is the average from three samples. The zinc-furnace particulate had a density of 1.54 g/cm^3. The background particulate sampled from the zinc-furnace building at ground level had a density of 1.08 g/cm^3.

C. Comparison of Results Between Plants

This section summarizes results from each of the plants for general comparison purposes. The emission rates in pounds per day for total particulate, lead, and arsenic, the lead-to-total particulate ratio, and the particle density are summarized in Table 19. Lead content by particle-size range is summarized in Figure 5. The comparison of species in total particulate is given in Table 20.

There are only two operations common to both plants where, on the average, the emission rates, the lead-to-total particulate ratio, and density might be compared directly. The sinter building at the Glover, Missouri, plant has a total particulate emission rate of 122 lb/day compared to 64.8 for the East Helena, Montana, plant.

TABLE 19

COMPARISON OF GLOVER PLANT AND EAST HELENA PLANT EMISSION RATE, LEAD-TO-TOTAL PARTICULATE RATIO, AND PARTICLE DENSITY COMPARISON

	Emission Rate in lb/day									
	T.P.[a]		Lead		Arsenic		Lead/T.P.[a] Ratio		Particle Density	
Operations	Glover	East Helena	Glover	East Helena	Glover	East Helena	Glover	East Helena	Glover	East Helena
Sinter-building	122	64.8	42.2	6.25	0.04	0.51	0.275	0.090	2.76	1.72
Blast-furnace	123	34.9	62.8	3.78	0.21	0.55	0.498	0.084	2.65[c]	2.16
Dross-kettles	-	300[b]	-	66.7[b]	-	30.3[b]	-	0.174[b]	-	3.27
Reverberatory-furnace	-	300[b]	-	66.7[b]	-	30.3[b]	-	0.174[b]	-	2.62
Zinc-fuming facility	-	14	-	1.49	-	0.06	-	0.084	-	-
Zinc-furnace	-	33.6	-	3.21	-	0.11	-	0.093	-	1.54
Ore-storage bins	8	-	3.84	-	< 0.01	-	0.508	-	3.67	-
Background	-	-	-	-	-	-	0.104	0.118[d]	1.2	1.08
Plant Total	253	447	109	81.4	0.25	31.5				

---

[a] T.P. = total particulate.

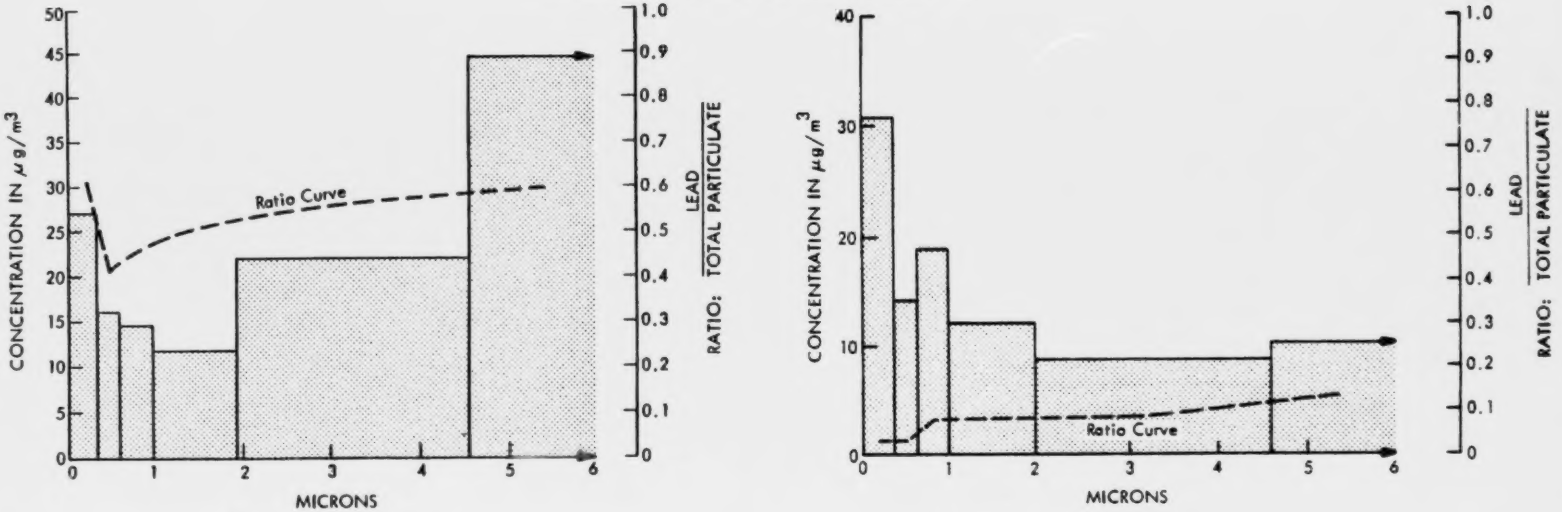
[b] Average of dross kettles and reverberatory furnace.

[c] An average of tapping operations (2.04) and charge-feed area (3.25).

[d] An average of ore-loading (0.217) and zinc-fuming area (0.019).

Concentration[1/] in $\mu g/m^3$			
Total Particulate	Lead	Ratio Lead/T.P.	Particle Size Range in Microns
652.0	30.8	0.047	<0.31
375.0	14.3	0.038	0.31 - 0.59
242.0	18.9	0.078	0.59 - 0.95
132.0	12.1	0.092	0.95 - 1.9
102.0	9.03	0.088	1.9 - 4.6
71.1	10.6	0.149	>4.6

[1/] Measured at Blast Furnace Roof Opening: Location 19



(a) Blast Furnace Tapping Operation:
Location 3; Glover, Missouri Plant

(b) Blast Furnace Roof Opening:
Location 19; East Helena, Montana Plant

Figure 5 - Comparison of Glover Plant and East Helena Plant Lead Content by Particle-Size Range Results

TABLE 20

GLOVER AND EAST HELENA PLANT SPECIES COMPARISON

	Sinter Building		Blast Furnace		Ore Storage[b]	Dross Kettles		Reverberatory Furnace	Zinc Fuming	Zinc Furnace	Background	
	G[a]	E[a]	G	E	G	G	E	E	E	E	G	E
ZnO	X	X		X			X	X	X	X		X
ZnS	X	X	X	X	X		X	X	X	X	X	X
$CaCO_3$									X			
As_2O_3							X					X
$CaSO_4$		X										
CdO				X								
Zn		X		X			X				X	
Pb		X	X	X			X	X		X		
PbO	X	X	X		X		X				X	
PbO_2	X										X	
PbS	X	X	X	X	X		X	X	X	X	X	X
$PbSO_4$	X	X	X	X	X		X	X	X	X	X	X
Sulfate	X	X	X		X		X				X	
Sulfide	X	X	X		X		X				X	

---

a/ G = Glover plant.
E = East Helena plant.

b/ There was no ore-storage area sampled in East Helena. There was not a dross-furnace, reverberatory-furnace, zinc-furnace or zinc-fuming operation at Glover, Missouri.

This difference is 57.2 lb/day more or 88%. The blast furnace comparison is 123 lb/day at the Glover plant and 34.9 lb/day at the East Helena plant. This difference is 88.1 lb/day or 252%. Comparing each plant's total particulate emission rate, the Glover plant has 253 lb/day, compared to 447 lb/day for the East Helena plant. This difference is 194 lb/day or the East Helena plant has a 76.7% greater emission rate.

The lead emission rates for the sinter buildings are 42.2 and 6.25 lb/day, respectively, for the Glover and East Helena plants. The Glover plant has 35.95 lb/day or 575% greater emission rate than the East Helena plant. The blast furnace at the Glover plant has a 62.8 lb/day emission rate compared to 3.78 lb/day for the East Helena plant. This is a 59 lb/day difference, or the Glover plant has a 1,500% greater emission rate of lead. The plant's total lead emission rates are closer. The Glover plant is 109 lb/day compared to 81.4 lb/day for the East Helena plant. This is a 27.6 lb/day difference, or the Glover plant has a 33.9% greater emission rate.

The arsenic emissions of the Glover plant are quite low--0.25 lb/day--in comparison with the East Helena plant, which has 31.5 lb/day. The major contributing operations at the East Helena plant are the dross kettles and reverberatory furnace, which combined give 30.3 lb/day, or they contribute 96.1% of the plant's total arsenic emissions.

Figure 5 gives both a tabular and graphic presentation of comparative lead content versus particle-size ranges. These results are given in two ways: lead content in micrograms per cubic meter and the ratio of lead-to-total particulate. These results compare the lead content in the emissions from the blast-furnace operations in each case.

Table 20 gives a comparison of species. There are only three areas for comparison--the sinter building, the blast furnace, and background. In these cases, there were differences in these species between the two plants. Since this was not an exhaustive analysis, it might be that there is more commonality than is indicated in the table.

III. PROCESS DESCRIPTION AND OPERATION

A description of the overall operation at each lead smelter is given below.

A. ASARCO Plant, Glover, Missouri

A general process layout of the smelter operation is given in Figure 6. This plant is on a 24-hr operational basis; however, the operation is frequently stopped because of ambient SO_2 levels. There were no shutdowns because of SO_2 levels during MRI's testing. This plant has no dross/reverberatory furnaces, zinc primary furnace, or acid plant.

Lead ore is brought to the plant by truck. The transfer of ore is to rail hopper cars at a point (Figure A-3) about 1/4 mile south of the plant's shipping and storage building (Figure 1). The ore is quite fine and moist (approximately 15% moisture). The transfer operation is an open-air one from the bed of a truck through grating in the road to railcars beneath the overpass roadway (Figures D-6 to D-8). The total drop is about 10 ft. This is an intermittent operation. The ore is then carried by these ASARCO-owned railcars to the west side of the operations area and unloaded. The ore drops from the bottom of the hopper cars through grates into storage bins. An overhead crane with clamshell is used to move the ore to bins that are contiguous to the west side of the sinter building from where it is belted to the sinter operation.

The charge to the sinter machine is made from measured amounts of material from four different feeders (coke breeze, blast-furnace dust, fluxes, and concentrate). The charge is then conveyed to a hammermill that breaks down the lumps and thoroughly mixes the material. The charge is conveyed first to a mixing drum and then a pelletizing drum. It is then transferred to the sinter machine, where the sulfur content is burned off. This sinter machine has an open, overhead gas-firing bed that produces fumes that rise and are emitted principally from roof openings.

The sinter is then placed into a charge car along with other materials (coke and scrap iron). The car makes 60 deliveries of charge per 24 hr to the blast furnace. At the blast furnace, smelting occurs. The furnace burns the coke with the aid of oxygen providing heat to melt the charge and to provide an agent to reduce the lead oxide formed in the sinter machine. As the molten lead flows down through the charge, it absorbs other metals, including silver, copper, antimony, bismuth, and tin. The molten furnace lead and molten slag are tapped from the bottom of the furnace. The slag components are regulated to provide a separation of the slag and lead.

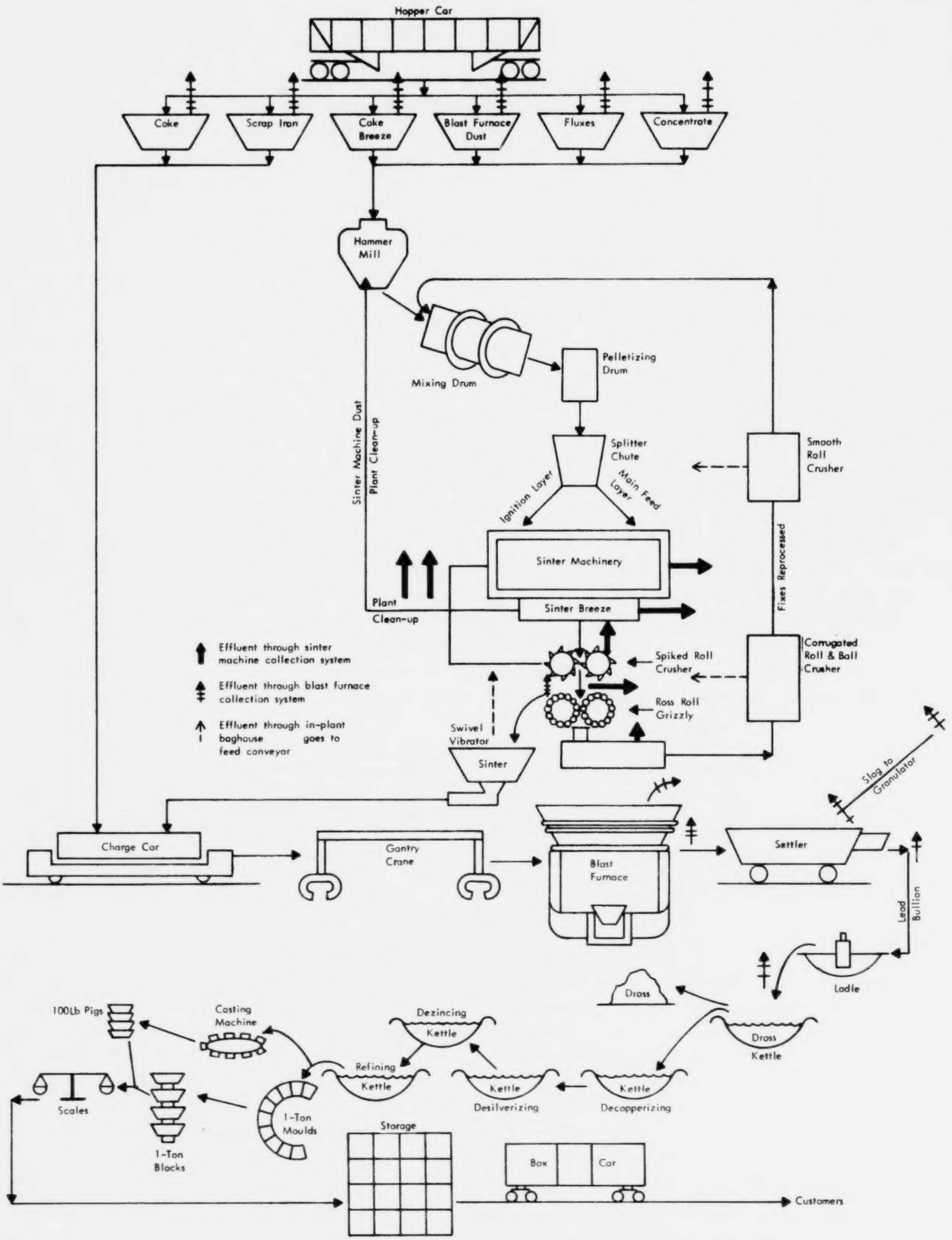

Hopper Car
Coke
Scrap Iron
Coke Breeze
Blast Furnace Dust
Fluxes
Concentrate
Hammer Mill
Mixing Drum
Pelletizing Drum
Sinter Machine Dust
Plant Clean-up
Splitter Chute
Ignition Layer
Main Feed Layer
Smooth Roll Crusher
Sinter Machinery
Fixes Reprocessed
Plant Clean-up
Sinter Breeze
Spiked Roll Crusher
Corrugated Roll & Ball Crusher
Ross Roll Grizzly
Effluent through sinter machine collection system
Effluent through blast furnace collection system
Effluent through in-plant baghouse goes to feed conveyor
Swivel Vibrator
Sinter
Slag to Granulator
Charge Car
Gantry Crane
Blast Furnace
Settler
Lead Bullion
Ladle
Dross
Dross Kettle
100Lb Pigs
Casting Machine
Dezincing Kettle
Refining Kettle
Kettle Desilverizing
Kettle Decopperizing
Scales
1-Ton Blocks
1-Ton Moulds
Storage
Box Car
Customers

Figure 6 - General Layout of the Smelter Operation at the ASARCO Plant in Glover, Missouri

The furnace lead is separated from the slag in a settler at the blast furnace. It takes approximately 45 min to fill a kettle at the blast furnace. The material is then transported via a crane to a location nearby and poured into a dross kettle. It takes 16 hr to fill one of the kettles. The dross kettle is then taken to the refinery where the various elements are separated. Zinc and copper are removed, and the lead is then formed into bullion.

B. ASARCO Plant, East Helena, Montana

A general process layout of the smelter operation is given in Figure 7. This plant is on a 24-hr operational basis; however, the operation is frequently stopped because of ambient SO_2 levels. There were no shutdowns because of SO_2 levels during MRI's testing. This plant has no refining area.

Concentrates and other materials are unloaded from railroad cars by means of a backhoe. The material, which is temporarily stored in open bins for short periods of time, is then conveyed by belt under covered transfer systems to one of several internal storage bins. The various components of the charge are then transferred from the storage bins to the ore-proportioning feeders.

The charge to the sinter machine comprises material from each of 10 feeders. The charge for the sinter is conveyed to a hammermill. There it is broken into lumps and thoroughly mixed. The mixed material is conveyed to a nodulizing drum. There water is added to form the charge into 3/8-in. diameter (on the average) nodules. The nodules are conveyed to a second nodulizing drum where return sinter is mixed with the charge, and then to the sinter machine. This sinter machine has a closed firing bed and trapped gases are drawn to an existing electrostatic precipitator. The purpose of the sinter machine is to eliminate the sulfur content of the charge by burning it off.

The coarse sinter is conveyed to a roast storage hopper at the blast-furnace charge floor. The roast is combined with coke and by-products in a charge car that transports this mixture to the blast furnace. The blast furnace is a water-jacketed rectangular column in which the charge is smelted. The smelting occurs when oxygen-enriched air is injected into the bottom of the ignited furnace. The blast air burns the coke, providing heat to melt the charge. It also provides an agent to reduce the lead oxide that was formed in the sinter process. As the molten lead flows through the charge, it absorbs other metals including gold, copper, silver, antimony, bismuth, and tin. The molten furnace lead and the molten slag are tapped from the bottom of the furnace. The slag components are carefully regulated to provide a clean separation of the slag and the lead.

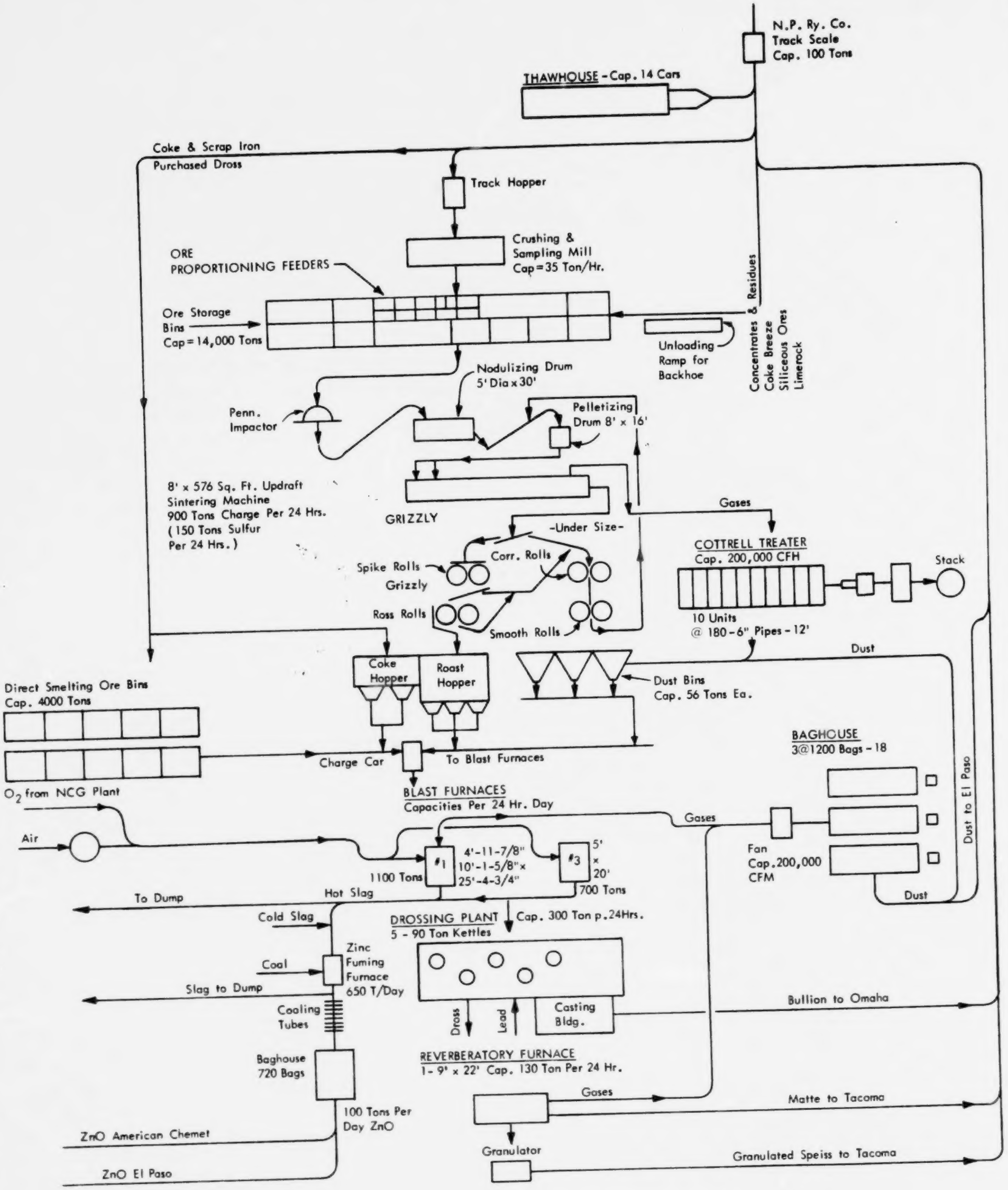

N.P. Ry. Co.
Track Scale
Cap. 100 Tons
THAWHOUSE - Cap. 14 Cars
Coke & Scrap Iron
Purchased Dross
Track Hopper
Crushing &
Sampling Mill
Cap = 35 Ton/Hr.
ORE
PROPORTIONING FEEDERS
Ore Storage
Bins
Cap = 14,000 Tons
Unloading
Ramp for
Backhoe
Concentrates & Residues
Coke Breeze
Siliceous Ores
Limerock
Nodulizing Drum
5' Dia x 30'
Penn.
Impactor
Pelletizing
Drum 8' x 16'
8' x 576 Sq. Ft. Updraft
Sintering Machine
900 Tons Charge Per 24 Hrs.
(150 Tons Sulfur
Per 24 Hrs.)
GRIZZLY
Gases
-Under Size-
COTTRELL TREATER
Cap. 200,000 CFH
Stack
Spike Rolls
Grizzly
Corr. Rolls
Ross Rolls
Smooth Rolls
10 Units
@ 180 - 6" Pipes - 12'
Dust
Coke
Hopper
Roast
Hopper
Dust Bins
Cap. 56 Tons Ea.
Direct Smelting Ore Bins
Cap. 4000 Tons
Charge Car
To Blast Furnaces
BAGHOUSE
3@1200 Bags - 18
O_2 from NCG Plant
BLAST FURNACES
Capacities Per 24 Hr. Day
Gases
Air
#1
4'-11-7/8"
10'-1-5/8" x
25'-4-3/4"
#3
5'
x
20'
1100 Tons
700 Tons
Fan
Cap. 200,000
CFM
Dust to El Paso
To Dump
Hot Slag
Dust
Cold Slag
DROSSING PLANT
5 - 90 Ton Kettles
Cap. 300 Ton p. 24Hrs.
Zinc
Fuming
Furnace
650 T/Day
Coal
Slag to Dump
Cooling
Tubes
Dross
Lead
Casting
Bldg.
Bullion to Omaha
REVERBERATORY FURNACE
1 - 9' x 22' Cap. 130 Ton Per 24 Hr.
Baghouse
720 Bags
Gases
Matte to Tacoma
100 Tons Per
Day ZnO
ZnO American Chemet
Granulator
Granulated Speiss to Tacoma
ZnO El Paso

Figure 7 - General Layout of the Smelter Operation at the ASARCO Plant in East Helena, Montana

A by-product of the blast furnace is cadmium dust. This material, along with smoke and fume from the blast furnace, is carried to and collected in a baghouse. The dust is recycled and then transferred into railroad cars (covered) for shipment to an ASARCO plant in El Paso, Texas.

The furnace lead is separated from the slag in a settler at the blast furnace. It is tapped from the settler in 10-ton uncovered pots and transferred to the drossing plant where it is poured into large uncovered kettles. The material is then cooled and stirred. This causes dross (a copper-bearing material) to rise to the top of the kettle. The dross is skimmed off by means of a crane and a clamshell bucket, and charged to a small reverberator furnace. The remaining lead bullion, which contains gold and silver and other impurities, is pumped into 10-ton molds and the material is shipped to an ASARCO plant in Omaha, Nebraska. The dross kettles and reverberatory furnace are contained in one long building.

The copper-bearing dross is melted in a reverberatory furnace, and three products are tapped from the furnace at different levels as determined by the specific gravity of the material. Matte and speiss (copper compounds) are tapped from the top two levels of the furnace, and lead is tapped from the bottom. The matte and speiss are shipped to ASARCO's copper smelter in Tacoma, Washington, and the lead is returned to the drossing plant to be shipped to ASARCO's plant in Omaha, Nebraska.

The molten slag from the blast-furnace settler flows into 5-ton pots. The pots are conveyed to a zinc furnace in a nearby building. The zinc is vaporized from the slag by blowing air and powdered coal into the bottom of the furnace. The charging and blowing cycle requires about 130 min for a 50-ton charge. The zinc vapor is exposed to outside air that changes it to white zinc oxide (zinc fume), the fume is cooled through a series of U-tubes and collected in a baghouse. Most of the collected dust is transferred to railcars for shipment to an ASARCO plant in El Paso, Texas. Dust shipped in closed hopper cars is left untreated while that shipped in open railcars is sprayed with a water-latex emulsion to prevent dust-loss enroute.

IV. LOCATION OF SAMPLE POINTS

The locations at which sampling took place are described for both the ASARCO plant in Glover, Missouri, and the plant in East Helena, Montana.

A. ASARCO Plant, Glover, Missouri

The process operations of the Glover plant are housed essentially under one roof (Figures A-1 and A-2). The smelter began operation in 1968. Drawings of this plant comprise Appendix A.

1. Sinter building: The sinter building represents an approximately 300 x 145 x 70 ft section of the main building (Figures A-4 and A-5). The west side is contiguous to the ore-storage area and is closed off while the other three sides are open from the ground to approximately mid-height. The building is also equipped with nine linear roof vent intervals. Since the prevailing wind is from the southwest, the roof vents and north end were chosen as sampling locations. Figure A-12 presents a plan layout of the sinter-building interior showing the locations of the major pieces of equipment.

Sampling Location 1 was taken at the north end of the sinter building (Figure A-8). This end consists of six bays approximately 24 x 34 ft. The sampling apparatus was placed at the center of the bay being sampled. Location 2 was taken at the roof vents of the sinter building (Figure A-11). These vents are approximately 4 ft wide by 4 ft high and of two lengths, 134 and 42 ft. Due to restrictions in gaining access to these areas, only two vents were chosen for sampling, a north site generally over the ignition end of the sinter machine, and a south site nearer the terminal end of the machine. The samplers were located horizontally approximately 12 ft from the east edge of the building and 1 ft below the roof line (Figure D-2).

2. Blast-furnace area: The blast-furnace, dross-kettle operations are located near the center of the main building (Figures A-2 and A-16). The charge car operates in the area north of the blast furnace and west of the sinter building. Positions north of the operations were chosen as sample sites because of the prevailing wind.

Location 3 was sited on the office building roof northeast of the dross-kettles and blast-furnace pouring area (Figures A-13 and A-16). This location is separated from the charging operation by a wall. The area between the dross kettles and sampling site is open for three-fourths the height. Location 3A was located east of the dross kettles to sample any drift not blown north by the wind (Figure A-13). Location 4 was sited north of the blast furnace and west of the wall adjacent to Location 3 (Figures A-2, A-13, and A-14). Location 4A was west of Location 4, just at the edge of the building (Figures A-1 and A-4).

3. Ore-bin area: The ore-bin-and-material-storage area is located north of the blast furnace and west of the sinter building. The east wall is closed while the west and north walls are almost totally open. The area is divided into several bins along a rail spur into which the various materials are dumped. Along the east wall are hoppers from which the materials are allocated to the sinter and charging operations.

Location 5 was placed at the northwest end of the bin area near the ore dumping sites (Figures A-1 and A-15). Location 5A was sited just west of Location 5 along the roadway.

4. Ore-transfer area: The truck-to-railcar transfer area is located approximately 1/4 mile southeast of the main buildings. The railcars are on spur tracks with the roadway on an overpass. The ore is dumped from the trucks, through grating, into the railcars for transfer to the ore-bin area. There are three truck lanes on the overpass, each with gratings, with two being used for lead ore. The third is used for material that never goes to any ASARCO plant operations area. There are three rail spurs corresponding to the three gratings.

Location 6* was on the overpass between the two lanes associated with lead ore (Figures A-18 and A-19). Two further sites* were located at track level, just east of the tracks, at a distance of 40 ft north and south of the overpass, Locations 6N and 6S, respectively (Figure A-3).

B. ASARCO Plant, East Helena, Montana

The process operations of the East Helena plant are housed in many noncontiguous buildings (Figure B-1). The smelter began operation in 1888. Drawings of this plant comprise Appendix B.

1. Sinter building: The sinter building is approximately 160 ft long, 130 ft wide, and 55 ft high. It is generally enclosed with the exception of roof vents, windows, and doors (Figures B-2 to B-6). Because the wind direction varies at this site, sampling locations were selected on three sides of the building as well as the roof.

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* These samples provided only background particulate concentrations because of the location of the samplers with regard to the transfer points, and and the fact that there was no visual indication of emissions. This latter point is substantiated by the fact that the ore was quite moist (approximately 15%).

Location 11 was selected at the middle of three roof openings and is above the sinter machine (Figure B-6). This opening was nearest the sinter ignition area. Location 12 was at an exhaust vent on one of the nodulizing drums (Figures B-5 and B-6). Sampling was done on the roof where the vent exhausted. Location 13 was along a walkway just outside the upper level of windows along the northeast side of the building (Figures B-2 and B-6). The sampler was raised to the level of the windows. This level of windows is just above the level of the sinter machine. Location 14 was along a walkway just inside the lower level of windows along the northeast side of the building (Figures B-2 and B-6). This level of windows is just below the level of the sinter machine. Location 14A was southeast of Location 14 along the same row of windows. Location 15 was one level below the sinter level just northwest of the machine itself, inside a window along the northwest side of the building (Figures B-5 and B-6). Location 16 was located just outside a window along the southeast side of the building (Figures B-4 and B-6).

2. Dross-kettle/reverberatory-furnace building: The dross/reverberatory building is approximately 180 ft long, 90 ft wide, and 60 ft high. It also is generally enclosed except for door openings and a roof vent running the length of the building. The roof vent is approximately 15 ft wide and 5 ft high. Location 17 was situated on a catwalk alongside the roof vent over the dross kettles (Figures B-10 and B-11). Location 18 was similar to Location 17 except that it was over the reverberatory furnace (Figures B-10 and B-11).

3. Blast-furnace building: Two blast furnaces are located in a building approximately 190 ft long, 40 ft wide, and 60 ft high. The furnace at the southwest end of the building is the newer of the two and is the most used. It is vented by an approximately 10 x 3 ft duct along the northeast wall. There is also an opening in the roof above the furnace itself. Location 19 was situated in the roof opening while Location 20 was the furnace vent duct (Figures B-12 and B-15).

4. Zinc-fume baghouse and rail-loading facility: The zinc-fume baghouse and rail-loading building is approximately 140 ft long, 85 ft wide, and 80 ft high. The rail-loading shed is adjacent to the main baghouse building along the northeast side. Adjacent to the southeast side of the baghouse building and extending southeast for approximately 250 ft are the zinc fume-condensing columns. At ground level below these columns is a tunnel-like area running the length of the columns and baghouse building that used to serve as the rail-loading area.

Location 21 was atop a 15-ft high scaffold at the east corner of the rail-loading shed (Figures B-16 to B-18). This was near the top of the railcars. Location 22 was at the southeast end of the tunnel area below the fume-condensing columns (Figure B-18).

5. Zinc-furnace building: The zinc-furnace building is approximately 45 ft long, 45 ft wide, and 60 ft high. The furnace vents through an 11 x 20 ft stack in the roof. Other openings are doors and windows in the walls.

Location 23 was at the exhaust stack on the roof (Figures B-20 and B-22). Location 23A was sited to the southeast of the building at ground level (Figures B-19 and B-22).

6. Ore unloading and storage area: The incoming ore is off-loaded from railcars and placed in open storage bins by use of a backhoe placed between the rail tracks and storage bins. The stored ore is moved from the bins to a conveyor belt utilizing a frontloader. There are three bins available for ore storage, and one for use of the frontloader in moving the ore.

Locations 24N and 24S were located north and south, respectively, of the ore-storage area (Figure B-1).

V. SAMPLING PROCEDURES

General comments on sampling procedures are given that pertain to both the Glover, Missouri, plant and the East Helena, Montana, plant. Then a more detailed discussion pertaining specifically to the procedures used at each plant is presented.

A. General Comments

As this study was associated with fugitive rather than source emissions, the equipment and methods used corresponded more to ambient sampling rather than to stack sampling. The major piece of equipment used for collection of the total mass samples was the High Volume Air Sampler (HiVol). Three models were used in this test: the General Metal Works Model 2000H; the Curtin Scientific Products Model 251-223; and the Unico Model 550 (Figures C-1 and C-2). The General Metal Works and Curtin models are equipped with Dickson Type 3-B-L-X Minicorders that record air flow through the sampler against time. The Unico model is a small, hand-held type that may be used with or without its stand. These samplers were operated either vertically or horizontally, depending on the sampling location. They are all designed to handle 8 x 10 in. glass-fiber filters. Another type of sampler used in obtaining total mass samples was the MRI-built profile sampling apparatus (Figures C-6, C-7, and C-9). This sampler can be used to obtain samples from up to four samplers arranged on a vertical mast. Samples from heights up to 14 ft 6 in. can be obtained with this apparatus, providing some measure of the vertical profile of the dust concentration. A hurricane blower on a valved-manifold system provides the vacuum, while magnehelic gauges indicate flow through each sampling head.

Cascade impactor samples to determine the particle-size range of the emissions were obtained by means of a 5-stage Sierra impactor. This unit was mounted on a General Metal Works Model 310 Accuvol for most of the runs done at the Glover plant (Figure C-3). This unit samples at 40 acfm regardless of the impactor loading or pressure drop. For the remainder of the Glover impactor tests, and for all of the East Helena impactor tests, the Sierra unit was mounted on a standard HiVol.

Air flow measurements were made both with fixed meteorological stations and hand-held velometers. Wong Laboratories EcoWIND III wind recording systems were used to obtain wind speed and direction (Figures A-3 and B-1). Data were also received from the various meteorological stations at the plants themselves. MRI units were located at Locations 1, 3, 4A, 5, and 6N at Glover and Locations 21 and 24S of East Helena. The ASARCO stations were north of the administration building at Glover and atop the sinter building (near Location 12) and midway up the zinc-fume baghouse stack (near Location 21) at East Helena. Direct air flow near the sampling heads was measured using either an Alnor Type 3002-2G air-vane velometer (Glover and East Helena) or a Hastings-Raydist Model AB-27 hot-wire air meter (East Helena) (Figure C-8). Taylor anemometers were also located on the sampling head brackets of the profile sampling apparatus.

The general approach to sampling the building sources was to place the sampler as close to the plant of the opening as possible. Background samplers were located as near the operation in question as practicable within the emission plume. Two samplers at the East Helena plant were modified to allow sampling from ducted sources by adding an auxiliary probe intake to the sampling head (Figure C-4). The predominant wind direction for each plant was determined, and the samplers were located generally downwind from the respective emission sources. Samplers were generally run for two lengths of time, 4 to 6 hr and 14 to 16 hr. The shorter runs were during the day, while the longer runs were overnight. This was done to obtain more samples in a given amount of time, and to provide larger sampling volumes and mass catches in case the lead and arsenic loadings were low. The overnight samples were run without observation by MRI personnel.

B. ASARCO Plant, Glover, Missouri

1. Sinter building: The profile sampling apparatus used at Location 1 consisted of a mast with sampling intakes for 8 x 10 in. glass-fiber filters at two heights (Figures C-6, C-9, and D-1). The bottom intake was 6 ft 6 in. above ground level and the top was 14 ft 6 in. above ground level. For Runs 1, 2, and 5, the profiler was positioned in the center of a single bay for the entire test. These were Bays 1, 3, and 3, respectively. For Run 3, the profiler was moved from bay to bay, sampling each bay for 45 min each, thus compositing the sample. Only five bays (Bays 2 to 6) were sampled before the process went down for the day. The sampling rate for each sampler was adjusted using magnehelic gauges, one per sampler, on the manifold of the profile apparatus (Figure C-7). A consistent 1.0 in. magnehelic reading for the entire sampling period gave a flow of air through each 8 x 10 in. filter of 38 acfm. A meteorological station was used simultaneously with operation of the profile apparatus. The meteorological station was positioned 100 ft to the north of the building, directly north of the northeast corner of the building in an open area (Figure A-3). For the impactor test at Location 1, an Accuvol fitted with a 5-stage Sierra impactor was placed on the trailer adjacent to the lower of the two 8 x 10 in. filter samplers of the profile sampling apparatus. The velocity of the air moving out of the building was measured using Taylor anemometers on each sampler (Figure C-5) and an Alnor velometer (Figure C-8) near the bottom sampler.

For Locations 2N and 2S, a HiVol sampler with 8 x 10 in. glass-fiber filter was positioned horizontally in the vents high above the sinter machinery in the east portion of the building (Figures C-2 and D-2). Samplers were placed in this opening so that the intakes of the HiVols were to the maximum extent possible, directly in the flow of hot gases and particulate matter coming from the sinter machinery. The air flow rate through the vent openings was measured at the same location as the intake of the samplers using the Alnor velometer. A gantry crane allowed access to these two samplers for MRI personnel.

2. Blast-furnace area: The HiVol sampler with 8 x 10 in. glass-fiber filter at Location 3 was placed on top of the office near the blast furnace (Figures A-16, A-17, C-1, and D-3). A meteorological station at the same location measured air flow from this end of the building. Since there is generally a south (180 degree) or southwest wind (225 degree), there is a large plume of particulate and gas from each blast-furnace-pour operation (transfer of material to dross kettles). A sampler was set downwind (just outside of the building) from the pour operation. The hand-held sampler with an 8 x 10 in. filter was also placed to the east of the blast-furnace-pour operations (Location 3A). For Runs 1 and 5 this sampler was operated only when pouring took place (Figure C-2). The sampler at Location 3A was operated continuously for Test Runs 2 and 4. The samplers at Locations 3 and 3A (and impactor tests) were operated in an upright position.

An upright HiVol was placed inside the building on a catwalk just north of the blast furnace (Location 4). Particulate matter from the blast-furnace charge-input area drifted in a northerly direction into the bin building where Sampler 4 was located. It is also true that two operations within the bin building (Figure D-4) generated some particulate material. However, negligible amounts are suspected to have been collected on the 8 x 10 in. filter at Location 4. First, the transferring of ore and other material from storage bins to hopper bins accounted for the generation of brief clouds of dust in various parts of the building. Second, the dumping of ore from railcars into storage bins resulted in some airborne particulate matter being suspended for short intervals within the building. An impactor test was performed at Location 4. A HiVol sampler was placed along the roadway just west of the edge of the bin building for one test (Location 4A). A meteorological station recorded wind direction and velocity there for Run No. 12.

3. Ore-bin area: A meteorological station and HiVol sampler were placed at Location 5 at the far north end of the bin building (Figure D-5). A 180 degree air movement from the far end and through the length of the bin building accounted for suspended matter drifting toward the vicinity of the Location 5 sampler. A separate sampling location was positioned outside the building along the roadway (Location 5A).

4. Ore-transfer area: Three HiVol samplers (with 8 x 10 in. filters) were used simultaneously at Location 6 (Figures A-18 and A-19). Location 6 is the dumping area for ore delivered to the plant by truck at various times during the day. Delivery began at approximately 7 a.m. each morning, and is finished by 6 p.m. daily. The capacity of each truck is approximately 20 tons. On an average, 30 loads per day were dumped. A sampler was placed on the overpass between two of the gratings, through which the ore is dumped into railcars. Another sampler and a meteorological station were positioned about 40 ft downwind (north) of the transfer site. A third sampler was placed about 40 ft upwind (south) of the transfer site. The samplers were operated in either of two ways: day test of 5 to 6 hr and overnight tests of approximately 14 hr. An Accuvol sampler was utilized for the Sierra impactor test at Location 6.

C. ASARCO Plant, East Helena, Montana

1. Sinter building: The roof opening above the sinter machinery, which is Location 11 (Figure C-2), was sampled with a horizontally placed HiVol that contained an 8 x 10 in. glass-fiber filter. The intake of the sampler was positioned to hang 6 in. over the edge of the roof opening so as to be, to the extent possible, within the stream of gases and particulate that traveled upward through the roof opening. The Alnor velometer and the Hastings air meter were used to make air-flow measurements (Figure C-8). A wood and steel platform with railings had been erected by a subcontractor to allow access to Location 11 from the top of the sinter building.

The HiVol sampler at Location 12 was equipped with an auxiliary intake (Figures C-4 and E-1 to E-3) to enable sampling of a small portion of the gas stream. The diameter of the vent duct was approximately 18 in. and the opening of the auxiliary intake was 2-1/2 in. diameter. No Sierra impactor sample was taken at Location 12.

The northeast side of the sinter building had two rows of window vents: one high, up about 1 level above the sinter machinery, and one in the middle, 6 ft lower than the sinter machine. Upright HiVol samplers were placed at Locations 13, 14, and 14A (Location 14A is 50 ft south of Location 14), the middle windows (Figures C-1, E-1, and E-2). Velometers were used to measure air flow out of these windows. The samplers were positioned so that the intakes were at a level approximately 6 in. above the lower edge of the windows. Test runs were made during the daytime with a sampling period of about 300 min, or overnight when the duration was 14 hr. A particle sizing test was performed at Locations 13 and 14 using the Sierra impactor.

Location 15 was placed at a window on the northwest side of the building at the same level as Location 14 (6 ft below sinter machinery). The sampler at Location 15 was operated upright and located so that the sampler intake was above the lower edge of the window. The Location 16 sampler was positioned upright, 3 ft outside the sinter building on a catwalk at the southeast face of the building. The sinter machinery was some distance away near Location 15. A large rotating drum exists near the southeast window, outside of which was Location 16. A Sierra impactor run was performed at Locations 15 and 16.

2. Dross-kettle/reverberatory-furnace building: Samplers 17 and 18 were located on top of the dross/reverberatory-furnace building on a catwalk and platform erected for this test. A 70-ft scaffold was used to gain access to the top of this building. Location 17 (dross) was an upright HiVol positioned between the roof and the vent roof--an opening of approximately 5 ft in height (Figure E-4). The position of the sampler corresponds to the location of the dross operations below. A large plume of gases and particulate arose from the dross operation regularly. Since the building is almost closed at ground level, the hot gas and particulate cloud rises and exits through the roof vent. Location 18 sampler was similarly placed over the reverberatory furnace (Figures E-3 and E-4). With a consistently northwest wind (315 degree), the cloud left the vent in the direction of wind flow (135 degree). The samplers were placed accordingly. Velometers were used to determine exit velocity at Locations 17 and 18. A test run with the Sierra impactor was conducted at each sampling location.

3. Blast-furnace building: Sampling Locations 19 and 20 were inside the blast-furnace building that contains equipment for charging (feeding) two furnaces. The areas of interest are at the charge locations where fumes and particulate matter leaving the upper portions of the furnaces exit through a roof opening above the blast-furnace charge inlet area, and through an opening adjacent to this opening through which fumes were emitted from the output of the blast furnace. An unusual occurrence results when the furnace "upsets,"* sending a large, dense cloud of gases, steam, and solid particles out the top of the building. This upset condition was the principal emission to sample. The preliminary survey revealed that an upset occurred on a random basis. There were some "upsets" during the period of our sampling.

Sampler 19 was placed on a suspended platform directly above the charging area of the blast furnace at the southeast part of the building and just below the roof opening (Figure E-5). The HiVol sampler was operated in the horizontal mode with an overhang of 6 in. An impactor test run was performed, but with the sampler upright.

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* Terminology used by plant personnel.

The Location 20 sampler was designed to gather particulate material exiting through the blast-furnace ventilation exhaust stack, which is to one side of the furnace itself (Figure E-5). The Location 20 sampler was equipped with the auxiliary intake for Test Runs 28, 29, 30, and 32. For the test run with the impactor, the auxiliary intake was not used.

4. Zinc-fume baghouse and rail-loading facility: The HiVol sampler at Location 21 was operated horizontally with the intake as close to the railcar loading hoppers as possible (Figures E-7 and E-8). The sampler was approximately 15 ft above the ground level near the top of the opening through which the railcars pass. A meteorological station was operated during the sampling period for Location 21. The station was positioned between the railcars and the hillside near the zinc stack. The consistent breeze from a direction of 270 degrees allowed effective sampling of the rail-loading operation. Location 22 sampler was placed in a 12 x 14 ft tunnel under the zinc-fume condensers at ground level (Figure E-6). It was operated in an upright mode. The 270-degree wind made for some dust and particulate matter moving through the length of the building, starting at the vicinity of the baghouse, leaving the building at the vicinity of Location 22.

5. Zinc-furnace building: Samplers 23 and 23A were located at the zinc-furnace building which is located in the eastern portion of the ASARCO plant (Figure E-9). The sampler at Location 23 was operated horizontally in the exhaust stack from the zinc furnace. A platform had been built by the subcontractor so that MRI personnel could place the sampler part way into the stack, overhanging the edge of the platform 6 to 8 in. The result was that the intake for the HiVol was near the center line of the stack, approximately 3 ft from one end. Access to this position was by ladder and existing stairway. Location 23A was a sampler placed upright on ground level outside and away from the zinc-furnace building. Particulate matter had been observed covering the ground at this location, so test runs were made to provide a general picture of ambient air concentrations. An impactor test run was made at each of these locations.

6. Ore-unloading and storage area: At Locations 24N and 24S (ore-unloading) samplers were placed upright at upwind and downwind positions in relation to the ore-unloading and storage area (Figure E-10). A meteorological station at Location 24S (downwind) gave wind-speed and wind-direction data. Wind-blown materials from the area where ore was being unloaded generally drifted southeasterly toward the tall stack. A natural narrows is created between the bins themselves and the baghouse building to the southwest; wind velocity through that location was exceptionally high. Dry dust and other material were subsequently picked up by winds and carried to the vicinity, and past Location 24S. Location 24N similarly received some blowing dust from other operations to the northwest and west of that location. Vehicular traffic through the area and especially on the roadway between the bins and the bag building made for a confusing situation

regarding accurate sampling of the ore-unloading operations. It is believed that the material collected on the filter at 24S represents at least several locations: dust from the surrounding roadway, dry dust from the ore in the bins, and some unidentified material resulting from a baghouse-cleaning operation that was in progress at the time.

VI. ANALYSIS PROCEDURES

A. General Comments

Particulate samples were collected at 13 locations at the Glover, Missouri, plant and at 17 locations at the East Helena, Montana, plant (Appendices A and B). The particulate was collected on 8 x 10 in. Gelman Type A-E glass-fiber filters for total mass and on 4 x 5 in. Sierra glass-fiber filters for total mass by aerodynamic particle-size ranges.

The population of the samples taken is identified in Table 21 for each test site (Glover, Missouri, and East Helena, Montana) by total number of samples and by four different population sets. Each of these five different categories was further subdivided by types of samples: Type 1 are 8 x 10 in. glass-fiber filters on which particulates were collected by using HiVol samplers (Figures C-1 and C-2) or by using MRI's vertical-profile sampling apparatus (Figures C-6 and C-9); and Type 2 are 4 x 5 in. glass-fiber filters on which particulates were collected by size ranges, using a Sierra 5-stage impactor in a HiVol air sampler (Figure C-3).

Since there are basically two different types of analyses--chemical and mathematical--each of these are presented separately below in Section VI-B and VI-C, respectively.

B. Chemical Analysis

The samples taken in the field are classified into four sets as shown in Table 21 and discussed above. Set 1, which comprised the total set of 200 samples (Type 1, 55 from Glover plus 60 from East Helena; and Type 2, 35 from Glover plus 50 from East Helena), was analyzed at MRI for the total mass of particulate on each filter. Set 2, which comprised 103 samples (Type 1, 35 from Glover plus 33 from East Helena; and Type 2, 25 from Glover plus 10 from East Helena), was analyzed at MRI for the quantity of lead and the quantity of arsenic in each sample. Set 3,* which was made up from Set 2, was analyzed at Physical Electronic Industries (Appendix F) for both lead and arsenic species. Set 4, which comprised 62 samples (Type 1, 13 from Glover plus 19 from East Helena; and Type 2, 5 from Glover plus 25 from East Helena), was analyzed by Walter C. McCrone Associates, Inc., for density and lead and arsenic species (Appendix G). Samples were sent to McCrone to be analyzed for density, and while there, McCrone also analyzed them for species.

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* Set 3 comprised samples from Set 2, i.e., seven of Type 1 and five of Type 2 from Glover, and eight of Type 1 and 15 of Type 2 from East Helena.

TABLE 21

SAMPLE POPULATIONS

Site	Total Number of Samples[a]		Set 1 Analyzed for Total Mass[c]		Set 2 Analyzed for Quantity of Pb and As[c]		Set 3 Analyzed for Pb and As Species[d]		Set 4 Analyzed for Density, Pb and As Species by Percent[e]	
	Type 1[b]	Type 2[b]	Type 1	Type 2	Type 1	Type 2	Type 1	Type 2	Type 1	Type 2
Glover, Missouri	55	35	55	35	35	25	7	5	13	5
East Helena, Montana	60	50	60	50	33	10	8	15	19	25

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a/ See Table 3.

b/ Type 1 are 8 in. x 10 in. glass-fiber filters on which particulates were collected by using HiVol samplers or by using MRI's vertical-profile sampling apparatus.
Type 2 are 4 in. x 5 in. glass-fiber filters on which particulates were collected by size range using a Sierra 5-stage impactor in a HiVol air sampler or in MRI's vertical-profile sampling apparatus.

c/ Analyzed by Midwest Research Institute.

d/ Analysis performed by Physical Electronic Industries.

e/ Analyzed by Walter C. McCrone Associates, Inc.

The analyses performed on the samples are discussed below: first, the analysis for total mass; second, the analyses by MRI for lead, arsenic, and cadmium mass; lead and arsenic species analyses by Physical Electronic Industries (PEI); and third, the analyses by McCrone for density and lead and arsenic species.

1. Set 1 - Samples analyzed for total mass: Prior to going to the field, all filters were tared at MRI in a temperature- and humidity-controlled room. The filters were in this room a minimum of 48 hr prior to being tared on a Gram-Atic Balance, Type B6, made by E. Mettler with a maximum balance of 106 g (0.5 mg ± 0.2 mg). After being tared, each filter was placed into a glassine envelope and in turn this envelope was placed into a manila envelope. Each filter was assigned a different number. The filter number and the tare weight of each filter were logged and written on the manila envelope.

After the filters had been used in the field, they were put back into their respective envelopes. Run numbers and dates of the sampling were recorded on the envelope.

Upon return of the filter samples to MRI, they were placed in the same temperature- and humidity-controlled weighing room for a minimum period of 48 hr before they were weighed. The same laboratory person who tared the filters weighed the filter samples. All weights were recorded.

2. Set 2 - Samples analyzed for concentration of lead and arsenic: This population of samples represented all the sampling locations at both the Glover, Missouri, site and the East Helena, Montana, site.

a. Experimental analysis: The instrumentation, chemicals and reagents, and procedures used are discussed below.

(1) Instrumentation: The measurements for the quantity of lead and arsenic in the samples were made on a Varian AA5 atomic absorption spectrophotometer with background correction. Lead and cadmium* concentrations were determined in air-acetylene flames. Arsenic concentration was determined in a nitrogen-hydrogen-entrained flame by the hydride method (converting arsenic to arsine and sweeping the gas through the same flame). The instrument settings were as described in the Varian Methods Manual.

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* Although cadmium was not a required analysis, it was included since it essentially was no additional effort.

(2) Chemicals and reagents: Reagent grade HCl and HNO_3 were prechecked for contamination and found to be below the detection limit for each element analyzed. The acids were used to make the aqua regia used for the digestion of the samples; the 5% HNO_3 used to rinse and dilute the samples to volume and to make the calibration standards; and the 50% HCl used in the hydride method. Commercially available atomic absorption standards were used as the stock solutions for the calibration standards. A 10% sodium borohydride, 10% sodium iodide in 1% sodium hydroxide solution was used to produce arsine, and gave no detectable arsenic signal.

(3) Procedure: A 4 x 4 in. section was cut from the 8 x 10 in. filter and weighed. The amount of filter tare was calculated, then subtracted from the weight of the section to obtain the weight of the particulate. The entire Sierra filter was used. The filters were cut into acid-washed beakers and 30 ml aqua regia were added. The samples were covered with cover glasses, heated on a hot plate for 4 hr, and occasionally stirred with glass rods to assure adequate contact of the particulate with the acid. The aqua regia was decanted into 100-ml volumetric flasks, the filters rinsed at least three times with 5% HNO_3, and the digested samples were diluted to volume with 5% HNO_3.

b. Discussion of analysis

(1) Preliminary considerations: Since the samples had been collected on filters, a method was chosen that would allow the removal of the particulate from the filters without dissolving the filters. Dissolution of glass-fiber filters by hydrofluoric acid requires very long digestion periods, results in high background levels, and a low recovery ($< 5\%$) of arsenic from the filters. Therefore, aqua regia rather than hydrofluoric acid was used to treat the samples. The aqua regia treatment resulted in dissolution of the particulate leaving a clean filter surface. Prior to the actual digestion of the samples, the ease of handling the filters and the recovery of fortified analyses from various acids, filters, and National Bureau of Standards Fly Ash No. 1633 were determined. The chosen method was a 4-hr leach in aqua regia.

(2) Results of particulate analysis: The concentration and total weight of lead, arsenic, and cadmium are given in Table 4. The concentration ranged from 0.62 to 69% for lead, 0.0062 to 9.6% for arsenic, and 0.01 to 16% for cadmium.

(3) Remarks: Most of the lead compounds expected are acid-soluble; one exception is lead-bound silicate, and another is one insoluble form of PbO. This form of PbO forms white platelets in aqua regia. Similar platelets were occasionally seen in some of the digested samples, but were a very low fraction of the total particulate. One sample was semiquantitatively analyzed by X-ray emission, and cadmium was detected. Since

cadmium is a hazardous material, the samples were also analyzed for cadmium by atomic absorption spectroscopy.

(4) Precision and accuracy: The relative standard deviations (RSD) of the atomic absorption methods were 1.7% for cadmium at the 50 ppm level, 3.6% for lead at the 100 ppm level, and 4.1% for arsenic at the 30 ppm level. The RSD of the hydride method was 3.7% for arsenic at the 0.3 µg level. The accuracy of the method for NBS fly ash was 98% for arsenic. The recovery of fortified filter blanks was 100% for arsenic and 100% for lead. The analysis of the filter blanks was 1.3 µg As, 8.8 µg Pb, and < 10 µg Cd for a whole Sierra, and < 0.6 µg As, < 0.5 µg Pb, and < 10 µg Cd for one-fourth of an 8 x 10 in. filter.

3. Set 3 - Samples analyzed for lead and arsenic species by Physical Electronic Industries: A portion of the samples was analyzed by Physical Electronic Industries, Minneapolis, Minnesota. This analysis is discussed below. Another portion of the samples was analyzed by X-ray diffraction by Walter C. McCrone Associates, Inc., Chicago, Illinois. This latter group is discussed in Section VI-B-4.

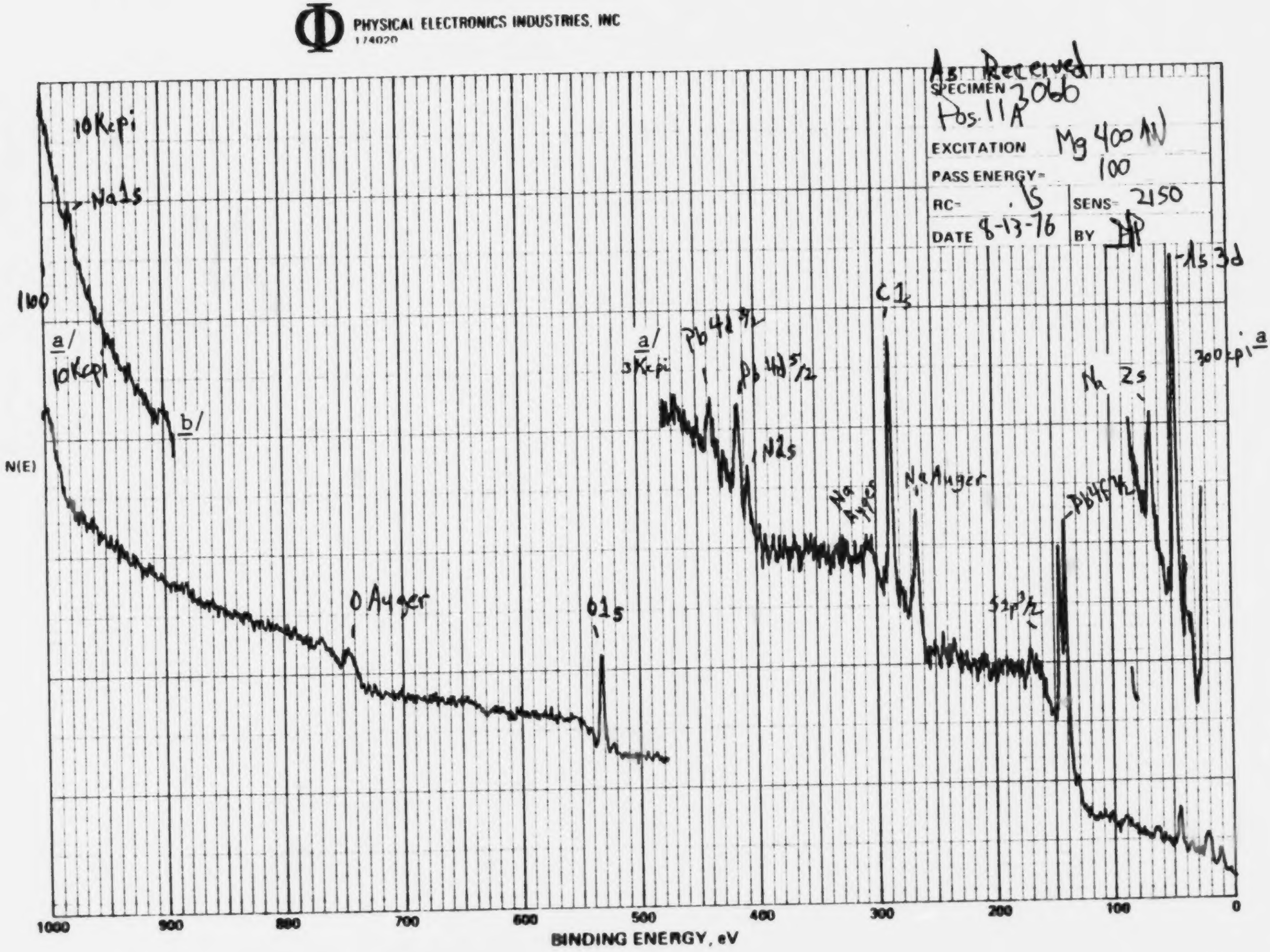
The instrumentation and procedures used are discussed below.

a. Instrumentation: The chemical species of lead were determined by electron spectroscopy for chemical analysis (ESCA) using a PHI Model 548. The analyses were performed by Physical Electronic Industries in their analytical laboratory. Samples for analyses were chosen from both smelter locations to be representative of sampling locations and particulate size distribution.

The ESCA results yield identification of the surface composition of the particulate material. A general scan was made of each sample which indicated elements present at greater than 1% concentration. The lead species were determined from a high-resolution scan of appropriate binding energies. Sulfur species were also determined from high-resolution scan because of the anticipated presence of lead sulfur compounds. Selected samples containing detectable arsenic levels (> 1%) were analyzed by high-resolution scan to determine arsenic species.

b. Discussion and conclusions: The following section discusses the different types of ESCA data obtained and how these data were interpreted. The ESCA data from all samples and Physical Electronic Industries' interpretation are included in Appendix F. The results of lead species identified for all the samples analyzed are then summarized.

The ESCA spectra from 1,000 to 0 ev binding energy were taken for each sample. An example is shown in Figure 8. The peaks detected were



a/ Kcpi = thousands of counts per inch.
Cpi = counts per inch.

b/ Binding energy scan from 1,100 to 1,000 ev.

Figure 8 - Elemental Scan of Sample No. 3066-Location 17, Dross Operations at East Helena, Montana, Plant

assigned to elements present, and to the orbital from which the electron came based on the binding energy. The important features of Figure 8 were the Pb $4f_{7/2}$ peak at 140 ev, and the As 3d at 45 ev. The presence of the lead and arsenic peaks indicated sufficient concentration (> 1%) to determine species present. The sulfur $2p_{3/2}$ peak at 160 ev is of low intensity with relation to the lead $4f_{7/2}$ peak. The fact indicated that sulfur could not be the predominate anion on lead.

All samples analyzed were on glass-fiber filters which electrically insulate the sample and build an electrostatic charge during ESCA. The electrostatic charge shifts binding energies and must be corrected during high-resolution analysis. Carbon was used to determine the binding energy correction. Figure 9 is a high-resolution scan in the carbon 1S binding energy. The accepted value for carbon 1S is 285.0 ev. As indicated in Figure 9, a -3.5 ev correction is necessary for this sample. The same correction is applied to all other high-resolution scans for other elements of interest in this sample. A carbon 1S scan was made for each sample, and the calculated binding energy correction was applied to the other elements analyzed.

Figure 10 is a high-resolution scan of lead $4f_{7/2}$ binding energy. This lead binding energy was selected because it shows the largest shift due to chemical species. The ESCA resolution is only 1 ev at half peak height, the binding energy of single compounds is indicated by 1 ev half height peak width, and the peak of a single compound is indicated in Figure 10. The corrected binding energy of 139 ev indicates the presence of PbO. If the $PbCrO_4$ were present, the Cr binding energy at 43 ev would be detected in Figure 10. The binding energies for lead species are given in Table 21. All values listed are corrected to carbon 1S = 285.0 ev. Figure 11 is of a sample that contains lead-sulfur and lead-oxygen bonds. When the signal strength of Figure 11 is compared to that of Figure 10, note the elevated signal strength between the lead $4f_{7/2}$ and $4f_{5/2}$ peaks. This indicates an unresolved peak which was assigned to either lead sulfate or lead sulfide. The binding energies are too close to resolve which sulfur species is present (Table 22). The binding energies of sulfur were used to assign the lead sulfur species (Table 23).

High-resolution scans were made of sulfur $2p_{3/2}$ in all samples. Table 23 lists the binding energies of sulfur-containing compounds. The two species of interest in this study were sulfate and sulfide with binding energies of 169 and 162 ev, respectively. Figure 12 shows a sample containing both sulfate (169.7 ev) and sulfide (162.8 ev).

Analysis of Figures 11 and 12 indicated the presence of lead-sulfur species, but from Figure 12 the lead species could not be assigned only as a sulfate or sulfide because of the presence of both sulfur forms. ESCA is a surface analysis technique, and it is possible that sulfide on the particulate surface may be oxidized to sulfate. To determine if this surface oxidation were occurring, Sample 2039 was sputtering to remove 100 Å of the surface.

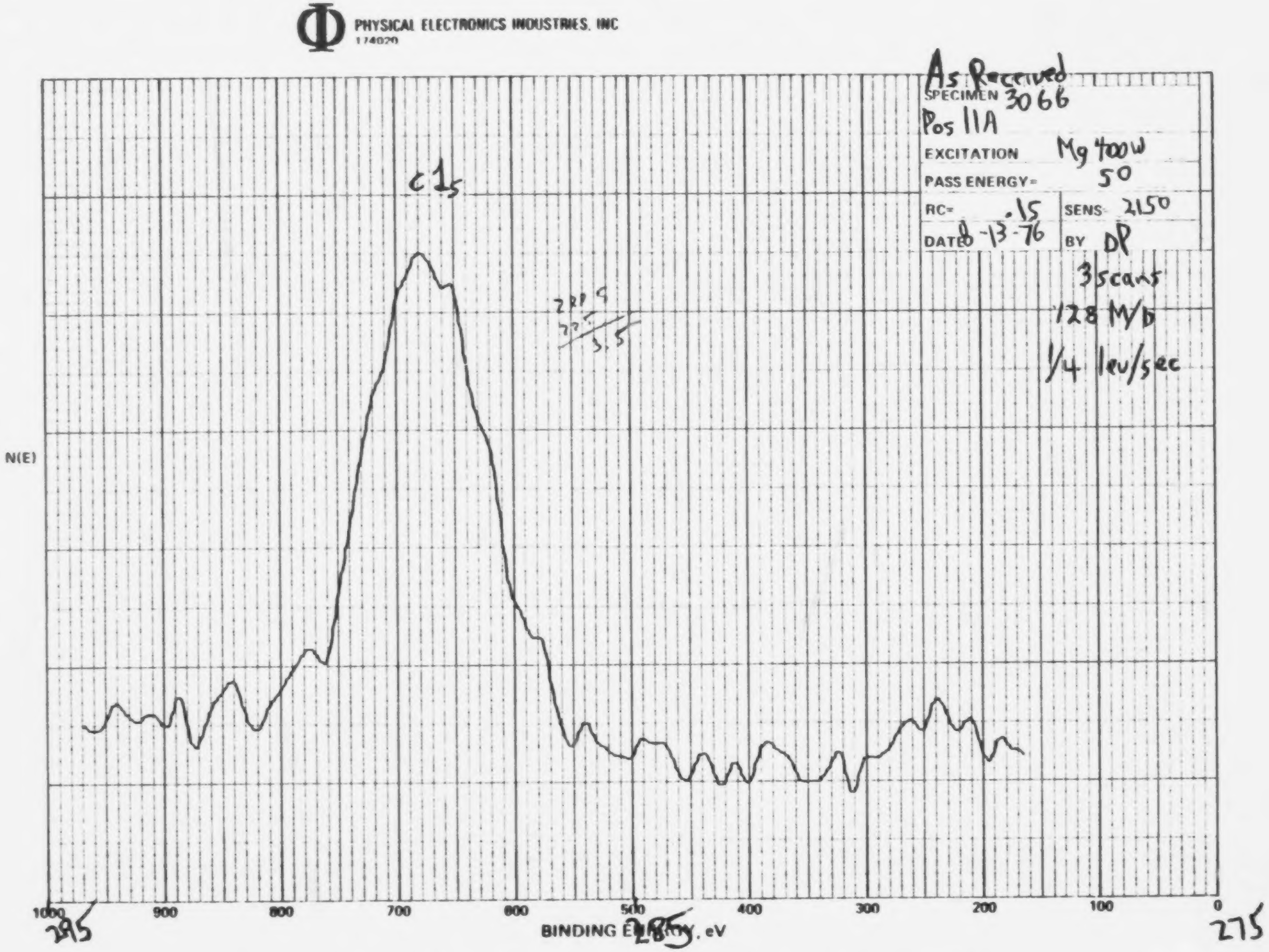


Figure 9 - Carbon Binding Energy Calibration for Sample No. 3066

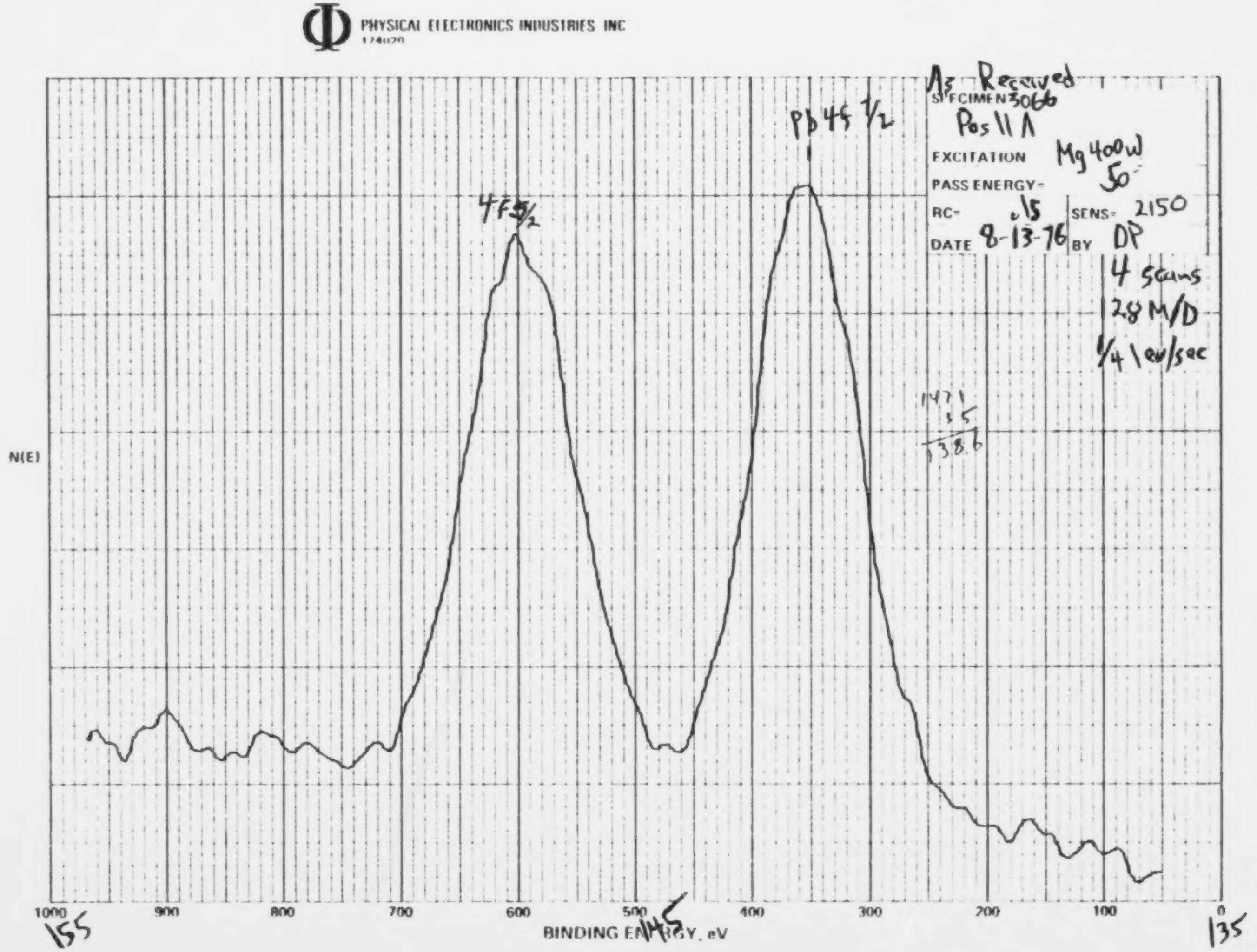


Figure 10 - Lead Species Determination for Sample No. 3066-Location 17, Dross Operations at East Helena, Montana, Plant

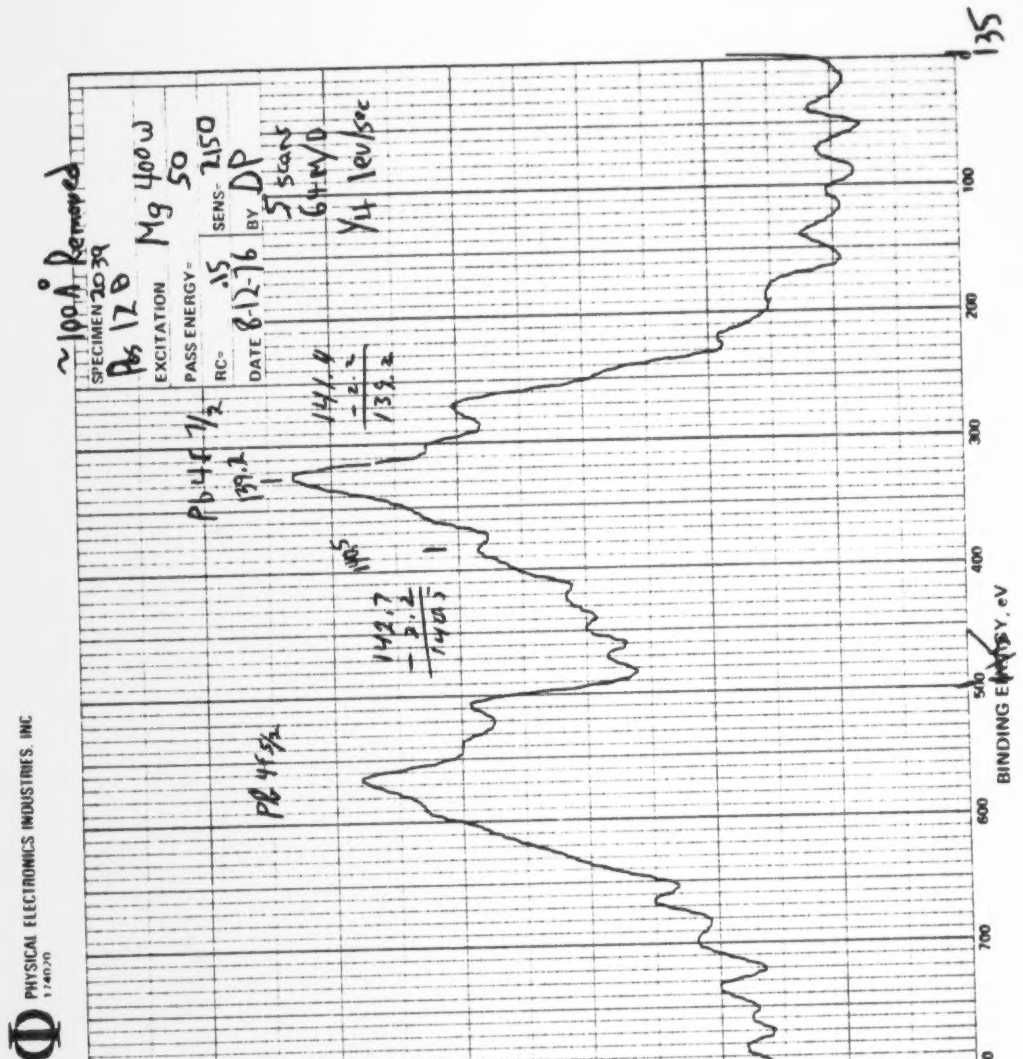


Figure 11 - Lead Species Determination for Sample No. 2039-Location 6S, Truck-to-Rail Transfer Point, Glover, Missouri

TABLE 22

$Pb(4f_{7/2})$ BINDING ENERGIES

Compound	Binding Energy (ev)[a]
Pb°	137.0 (136.9)[b]
PbO_2	137.0 (137.5)[b]
$Pb[S_2P(OCH_2H_5)_2]_2$	138.3
$PbCrO_4$	138.3
PbO	139.2
$PbCO_3$	140.0
PbF_2	140.9
PbS	141.0
$PbSO_4$	141.1
PbI_2	141.8
$Pb(NO_3)_2$	142.2

---

[a] T. A. Carlson, Photoelectron and Auger Spectroscopy, Plenum Press (1975).

[b] K. S. Kim, T. J. O'Leary, and N. Winograd, Anal. Chem., 45:2214 (1976).

TABLE 23

SULFUR (2p) BINDING ENERGIES

Compound	Binding Energy (ev)[a]
Na_2S	162.0
S_2Cl_2	163.7
S_8	164.2
Na_2SO_4	166.7
$Fe_2(SO_4)_3$	168.9
SOF_2	170.2
S_2F_{10}	174.6
SF_6	177.4

---

[a] T. A. Carlson, Photoelectron and Auger Spectroscopy, Plenum Press (1975).

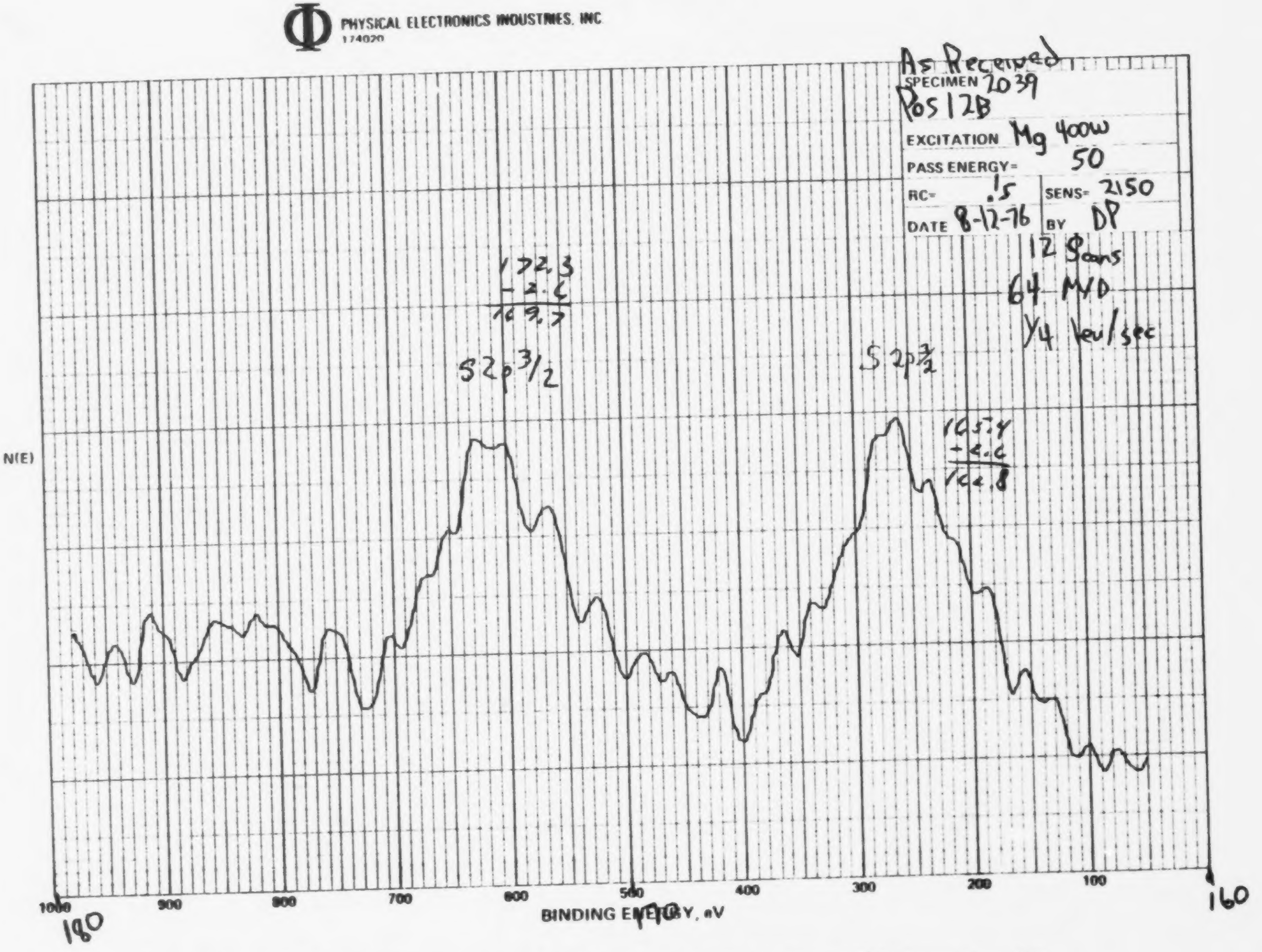


Figure 12 - Sulfur Species Determination for Sample No. 2039-Location 6S, Truck-to-Rail Transfer Point, Glover, Missouri, Plant

The sample was again analyzed for lead and sulfur species. The lead-sulfur bond was detected again, but the sulfur analysis shown in Figure 13 indicated the presence of sulfide and not sulfate. Similar sputtering experiments were performed on Samples 3001, 3004, and 2027. In each case, the removal of the surface caused an increase in the sulfide peak. In Samples 3004 and 2039, the PbO_2 was associated with the surface and disappeared when the original surface was removed. Sample 3001 and 2027 did not indicate any PbO_2 on the original surface.

Arsenic was detected in some samples from East Helena, Montana (Figure 8). The concentration was sufficient to justify a high-resolution scan of arsenic 3d binding energies in an attempt to determine arsenic speciation. The binding energies for arsenic are presented in Table 24. The difference in binding energies of the arsenic III and V oxidation states were too low for oxidation state identification of either the oxides or sulfides. The binding energy difference between the sulfide and oxide is sufficient to differentiate between the two anion forms. Figure 14 is a high-resolution scan of arsenic binding energies which indicate the presence of arsenic sulfide.

TABLE 24

As (3d) BINDING ENERGIES

Compound	Binding Energy (ev)[a]
InAs	41.3
As	42.0
As_2S_3	43.7
As_2S_4	44.3
$(C_6H_5)_3As\ O$	44.6
K_3AsO_4	45.2
$Na_4As_2O_7$	45.6
As_2O_3	46.0
As_2O_5	46.4
$KAsF_6$	47.9
$LiAsF_6$	49.3

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[a] T. A. Carlson, Photoelectron and Auger Spectroscopy, Plenum Press (1975).

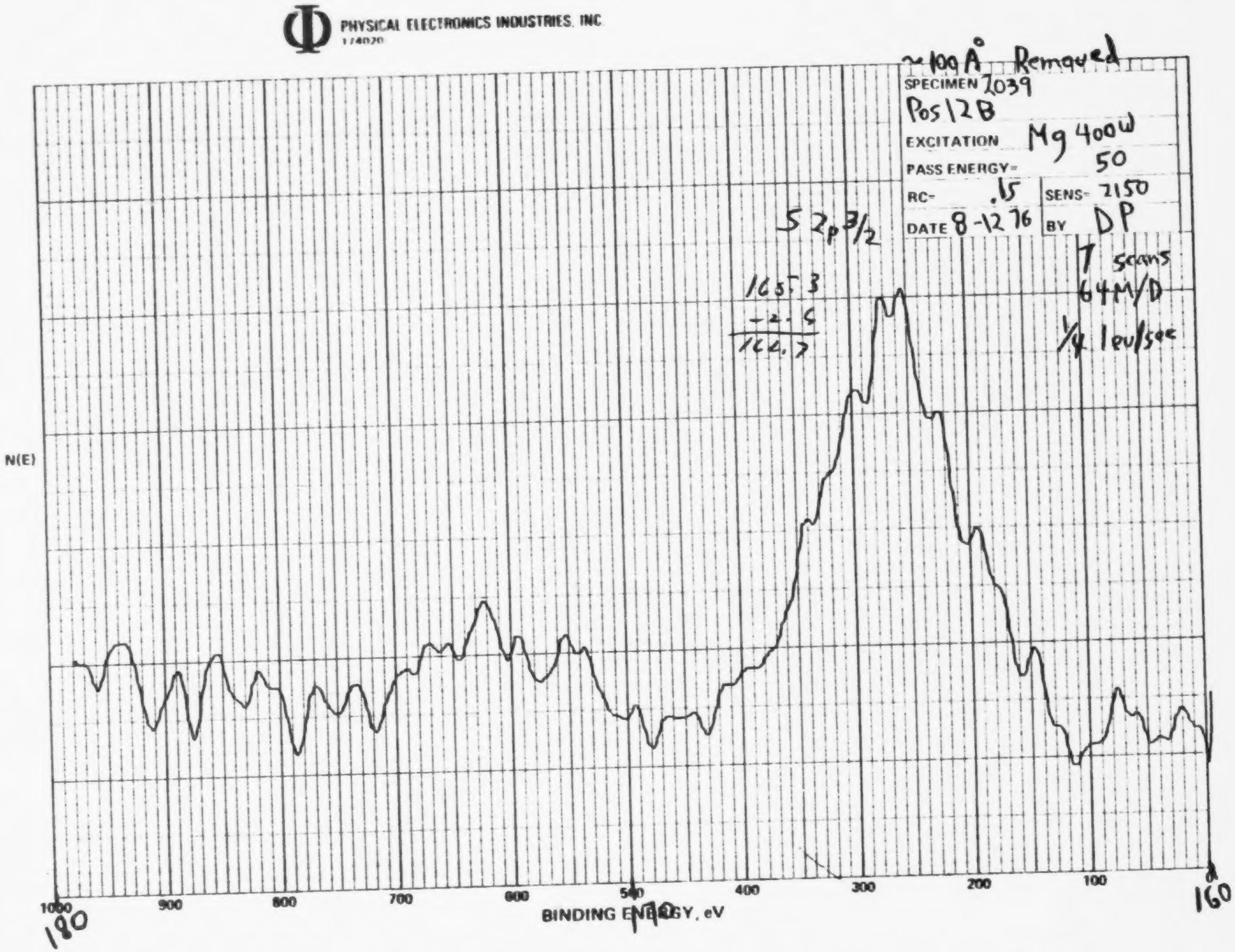
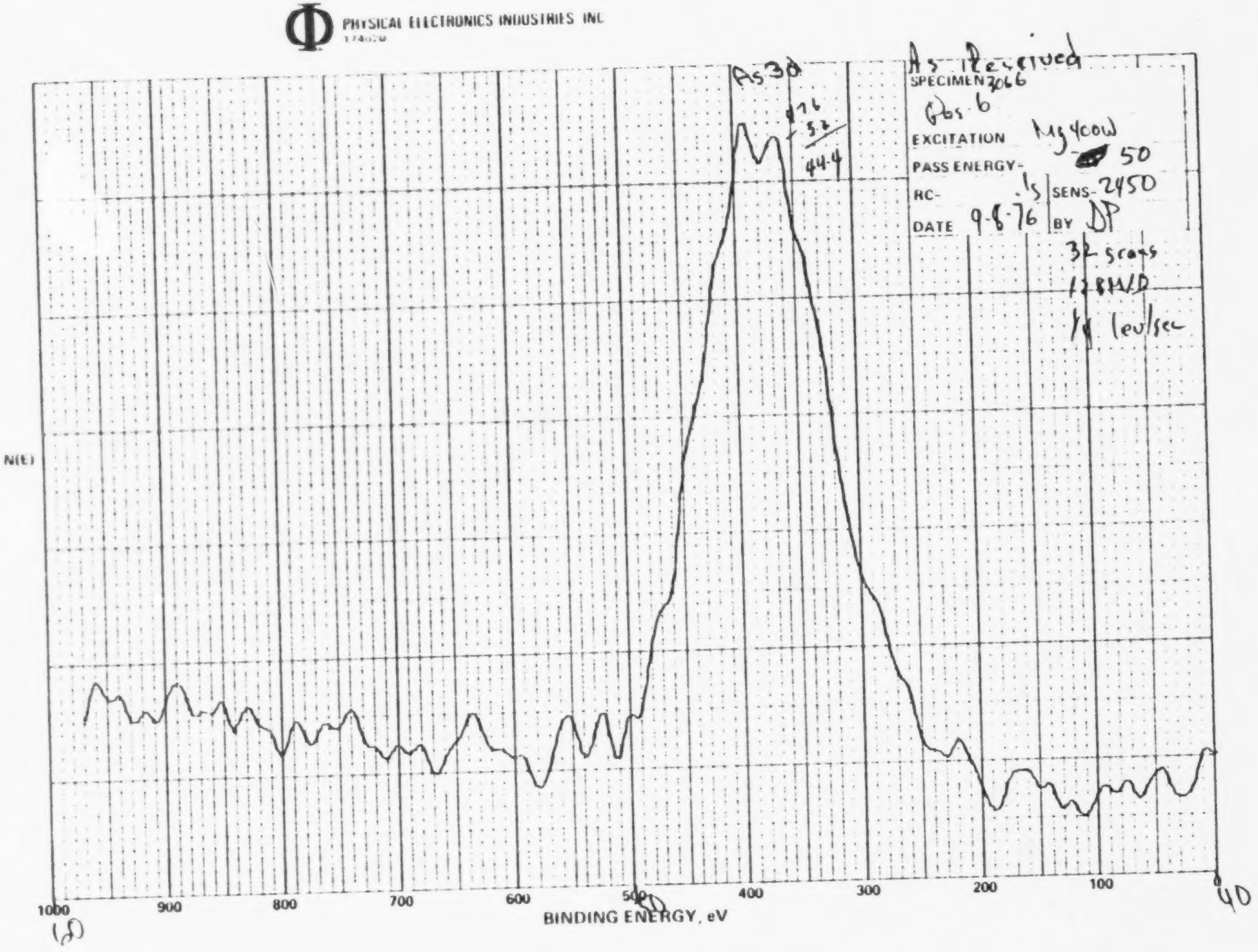


Figure 13 - Sulfur Species Determination for Sample No. 2039-Location 6S, Truck-to-Rail Transfer Point, Glover, Missouri, Plant



As Received
SPECIMEN 3066
Gbs 6
EXCITATION Mg 400W
PASS ENERGY- 50
RC- .1s
SENS- 2450
DATE 9-8-76
BY DP
32 scans
12.8 MID
1/4 lev/sec

Figure 14 - Arsenic Species Determination for Sample No. 3066-Location 17, Dross Operations at East Helena, Montana, Plant

The low-resolution scan of Sierra Samples 3062 to 3066 and 3077 to 3087 indicated an increase in arsenic peak height as the particulate size decreased. The peak height of a given element's binding energy is directly proportional to its concentration on the surface. Figure 15 shows the relation between arsenic concentration and the inverse of the particulate diameter. This clearly indicates a direct relationship between particulate size and arsenic concentration. An explanation for this observation is that arsenic was vaporized during the smelting operation. As the gas was cooled, the arsenic condensed on particulate surfaces. The smaller particulates have a greater surface area per given weight of material, and therefore show an enrichment in arsenic concentration. The sampling area of the ESCA is fixed in size so that large particulates show smaller total surface area than smaller particulates for the same surface area coverage of the filter. Therefore, the arsenic concentration increases with decreasing particle size.

The ESCA results are summarized in Table 25. The predominate lead surface species in all samples was PbO. Several samples contain PbO_2, but this is likely a result of surface oxidation of PbO as determined from the surface sputtering experiments discussed above. Only Samples 2032 and 2099 had lead sulfide on the surface. Sputtering experiments on selected samples indicated no additional lead sulfide at depth up to 200 Å. There is no indication of any surface dependence of lead species based on size or location. There is no indication of an increase in surface lead concentration (as determined by peak height) as particulate size decreases.

The ESCA results are significantly different from the X-ray diffraction results with respect to lead species. It should be emphasized that the ESCA results are for particulate surfaces, and independent of crystalline composition. The microscopic examination of the particulates indicated amorphous material which would not be detected by X-ray diffraction. The X-ray diffraction yielded information about the particulation at a greater depth. The ESCA technique would be more comparable to the X-ray diffraction if sputtering techniques had been used extensively. The two techniques are looking at the particulate matter in very different ways, and comparison of the results between the two procedures cannot be made.

4. Set 4 - Samples analyzed for density: McCrone was not able to analyze the samples for density because there was no solution available sufficiently heavy for density determination by gradient methods (maximum of 3.33 g/cm^3). However, the species percent composition results from McCrone did make possible the determination of the density (Section VI-C-5).

The species determination was done by X-ray diffraction. The copies of the original X-ray patterns are given in Appendix G. The percent composition results are given in Table 26. The identification of each of these phases was confirmed by light microscopy.

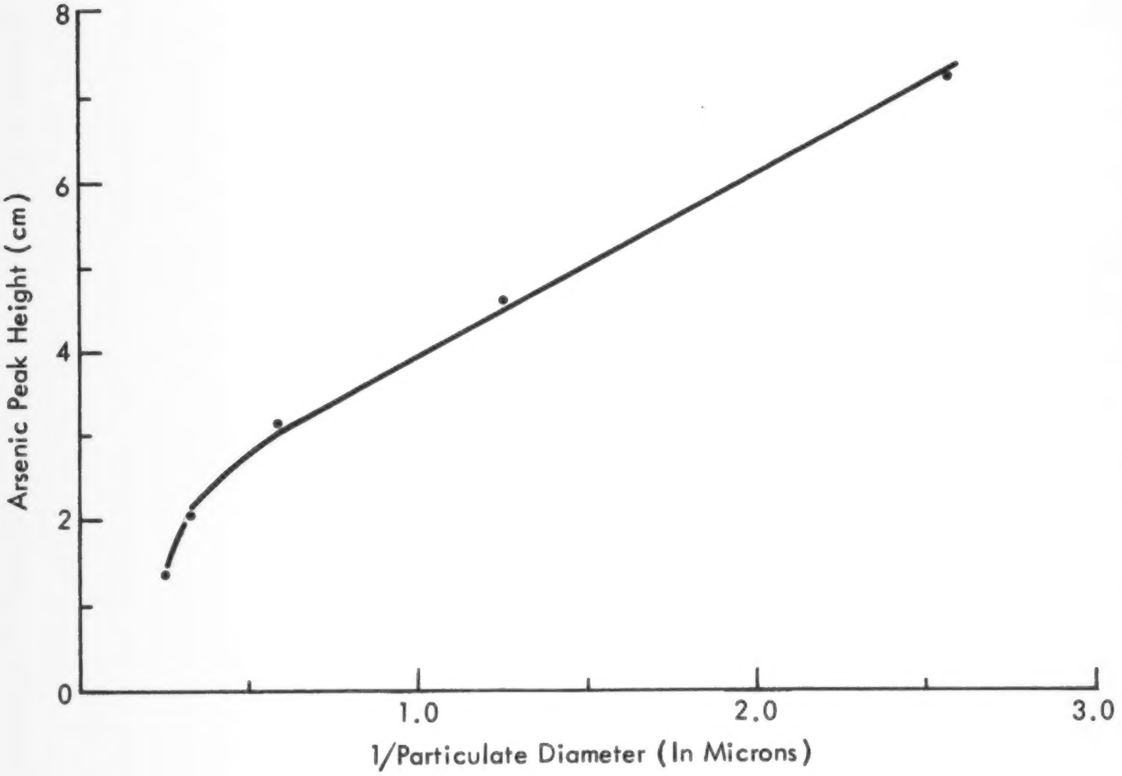


Figure 15 - Arsenic Concentration by Particulate Size for Samples
3063 to 3066, Location 17, Dross Operations at
East Helena, Montana, Plant

TABLE 25

Pb SPECIES PRESENT AS DETERMINED BY ESCA

Sample No.	Location	Stage	PbO	PbO_2	PbS	Sulfate[a]	Sulfide[a]	Comments
3000	1	5	X			X		
3001	1	4	X			X	X	Trace PbO_2
3002	1	3	X	X		X		
3003	1	2	X			X	X	Trace PbO_2
3004	1	1	X	X		X	X	PbO_2 on surface only
2007	1	Backup	X	X		X	X	
2032	1B		X			X		Trace PbO_2
2027	2N		X			X		Chloride present
2033	3		X			X		Trace PbO_2
2047	4		X			X	X	
2042	5		X			X	X	
2039	6S		X	X	X	X	X	Zinc and chloride present
3042	11		X			X		Zinc present
3043	11		X			X		Trace of PbO_2, zinc present
3044	11		X			X		Zinc present
3045	11		X			X		Zinc present
3046	11		X			X		Zinc present
2069	11	Backup	X			X		Zinc present
3062	17	1	X			X		Arsenic at > 1% detected, Zn present
3063	17	2	X			X		Arsenic at > 1% detected, Zn present
3064	17	3	X			X		Arsenic at > 1% detected
3065	17	4	X			X		Arsenic at > 1% detected, Zn present
3066	17	5	X			X		Arsenic at > 1% detected
2108	17	Backup	X			X		Arsenic at > 1% detected, Zn present

TABLE 25 (Concluded)

Sample No.	Location	Stage	PbO	PbO2	PbS	Sulfate[a]	Sulfide[a]	Comments
3077	18	1	X			X		Arsenic at > 1% detected
3078	18	2	X			X		Arsenic at > 1%
3079	18	3	X			X		Arsenic at > 1%
3080	18	4	X			X		Arsenic at > 1%
3081	18	5	X			X		Arsenic at > 1%
2077	11		X			X		Ca, Zn, N present
2099	23A		X		X			Very low lead, sulfur could not be detected
2100	24N		X			X		Zn present, high amount of nitrogen
2113	17		X			X	X	Arsenic at > 1% detected, Zn, W present

---

[a] Sulfate and sulfide are not associated with lead except Samples 2039 and 2099.

TABLE 26

PERCENTAGE COMPOSITION OF SPECIES AS DETERMINED BY X-RAY DIFFRACTION

Sample	Species									
	Pb	PbS	$PbSO_4$	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn
2002	-	85	12	-	3	-	-	-	-	-
2004	-	60	10	-	30	-	-	-	-	-
2006	10	70	10	-	10	-	-	-	-	-
2013	-				Insufficient Sample					
2015	-	70	10	-	20	-	-	-	-	-
2016	5	75	8	2	10	-	-	-	-	-
2025	-	70	20	-	10	-	-	-	-	-
2026	-	85	10	-	5	-	-	-	-	-
2031	-	80	10	-	10	-	-	-	-	-
2035	-	75	5	-	20	-	-	-	-	-
2038	-	75	15	-	10	-	-	-	-	-
2040	-	40	10	-	50	-	-	-	-	-
2055	-	75	25	-	-	-	-	-	-	-
2057	-	75	15	-	10	-	-	-	-	-
2070	-	55	20	-	25	-	-	-	-	-
2071	-	25	20	-	40	-	-	15	-	-
2072	10	45	25	-	20	-	-	-	-	-
2073	5	55	20	-	20	-	-	-	-	-
2074	10	55	20	-	15	-	-	-	-	-
2081	-	2	28	70	-	-	-	-	-	-
2082	15	10	10	60	5	-	-	-	-	-
2083	-	60	15	10	15	-	-	-	-	-
2084	-	40	15	15	30	-	-	-	-	-
2086	-	15	15	40	10	20	-	-	-	-
2087	-	30	15	15	10	30	-	-	-	-
2091	10	3	5	72	10	-	-	-	-	-
2103	10	10	5	70	5	-	-	-	-	-
2104	15	15	10	50	10	-	-	-	-	-
2106	45	40	10	-	5	-	-	-	-	-
2107	30	50	10	5	5	-	-	-	-	-
2109[a]	15	35	40	-	10	-	-	-	-	-
	(30)	(10)	(20)	(30)	(10)					
2117	15	48	2	-	-	-	35	-	-	-
2126	-	-	-	90	10	-	-	-	-	-
3005					Insufficient Sample					
3006	-	80	10	-	10	-	-	-	-	-
3007	-	70	20	-	10	-	-	-	-	-
3008	-	85	5	-	10	-	-	-	-	-
3009	-	85	10	-	5	-	-	-	-	-
3010	-	75	20	-	5	-	-	-	-	-
3047	5	60	15	2	18	-	-	-	-	-
3048	10	55	15	5	15	-	-	-	-	-

TABLE 26 (Concluded)

	Species									
Sample	Pb	PbS	$PbSO_4$	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn
3049	2	60	20	10	8	-	-	-	-	-
3050	5	50	40	5	-	-	-	-	-	-
3051	10	45	45	-	-	-	-	-	-	-
3052	-	-	25	60	15	-	-	-	-	-
3053	5	10	15	65	5	-	-	-	-	-
3054	10	10	20	50	10	-	-	-	-	-
3055	20	10	10	52	8	-	-	-	-	-
3056	-	10	12	70	8	-	-	-	-	-
3067	20	50	15	5	10	-	-	-	-	-
3068	10	65	15	3	5	-	-	2	-	-
3069	30	50	10	10	-	-	-	-	-	-
3070	30	15	30	25	-	-	-	-	-	-
3071	-	2	28	70	-	-	-	-	-	-
3082	35	65	-	-	-	-	-	-	-	-
3083	30	70	-	-	-	-	-	-	-	-
3084	15	50	-	8	10	-	17	-	-	-
3085	-	60	5	20	-	-	15	-	-	-
3086	15	35	-	10	-	-	40	-	-	-
3087	20	40	20	10	10	-	-	-	-	-
3088	10	20	10	15	5	-	-	-	-	40
3089	15	5	5	55	-	-	-	-	10	10
3090	10	-	5	55	5	-	-	-	-	25
3091	5	-	8	65	4	-	-	-	8	10
Densities	11.34	7.5	6.2	5.61	4.10	2.71	3.74	2.96	8.15	7.14

---

a/ Sample 2109 was analyzed on the filter directly, results in (); and as powder removed therefrom. The filter deposit was layered, black on the bottom and white (ZnO) on top.

There was an insufficient sample on Samples 2013 and 3005 to analyze.

C. Mathematical Analyses

1. General comments: The mathematical calculations that were performed required wind direction, wind velocity, ambient temperature, barometric pressure, sampler flow rate, duration of sampling, weight of sample, and effective area. The climatological raw field data that were used are given in Appendices H through J. At both sites, meteorological data from ASARCO weather stations were obtained, as well as data from MRI meteorological stations that had been set up at sampling locations where this information was needed.

The flow rates of some of the samplers were constant. Others varied within acceptable bounds. In the latter case, flow records from the individual samplers were taken during sampling. Copies of these records comprise Appendices K and L.

The duration of the sampling period was recorded by field personnel. These data are summarized in Table 3.

The weight of the total particulate and the lead and arsenic contents of a sample were determined as discussed in the preceding section (Section VI-B).

The effective area is a complex aspect of the mathematical calculations. It is a factor that represents the emission profile (two-dimensional aspect) at an emission point. Calculation data sheets on this subject are given in Appendix M.

2. Climatological data: These data comprise wind velocity, wind direction, ambient temperature, and barometric pressure. The average wind velocity and direction data given in Table 3 are the average vector values that were determined from the raw data given in Appendices H and I, respectively. These average vector values were used in the calculations.

The temperature and barometric pressure data given in Table 3 are average values of the ambient temperatures and barometric pressures recorded during the sampling periods. The temperatures and barometric pressures in all cases were obtained from the ASARCO on-site weather stations. The average values were used in the evaluations.

3. Volume sampled: The volume sampled was calculated by using the following equations:

$$\text{Volume}_{\text{act.}}\ (\text{m}^3) = \text{Sampler rate}\left(\frac{\text{ft}^3}{\text{min}}\right) \times \text{Duration (min)} \times 0.028317\left(\frac{\text{m}^3}{\text{ft}^3}\right) \quad (1)$$

and

$$\text{Volume}_{\text{std.}}\ (\text{m}^3) = \text{Vol}_{\text{act.}}\ (\text{m}^3) \times \frac{537°}{29.92} \times \frac{\text{Barometric pressure}}{\text{Temp. °F} + 460°}\ , \quad (2)$$

where

0.028317 is the factor for converting ft^3 to m^3 .

An example is:

Given: Run 1, Location: 1-top

Sample Rate = 37.25 cfm
Sample Duration = 222 min

Determine:

$$\text{Vol}_{\text{act.}} = 37.25 \times 222 \times 0.028317 = 234\ \text{m}^3$$

$$\text{Vol}_{\text{std.}} = 234 \times \frac{537}{29.92} \times \frac{30.54}{90.3 + 460} = 233\ \text{m}^3$$

4. Concentrations of total particulate, lead, arsenic, and cadmium: Actual and standard concentrations were calculated by using the following equation:

$$\text{Concentration}\ (\mu\text{g/m}^3) = \frac{\text{weight}\ (\mu\text{g})}{\text{volume}\ (\text{m}^3)} \quad (3)$$

where weight is the mass as determined by gravimetrical methods as discussed in Section VI-B; and

volume is either the actual or standard volume as determined by Eqs. (1) and (2), respectively.

An example is:

Given: Run 3, Location: 1-top

Total particulate mass = 1.5784 g
Lead weight = 700 mg
Arsenic weight = 550 μg
Cadmium weight = 4,600 μg
Volume$_{\text{act.}}$ = 234 m^3
Volume$_{\text{std.}}$ = 233 m^3

Determine:[*]

$$\text{Total Particulate Concentration}_{\text{act.}} = \frac{1.5784}{234} = 6{,}740\ \mu\text{g/m}^3$$

$$\text{Total Particulate Concentration}_{\text{std.}} = \frac{1.5784}{233} = 6{,}770\ \mu\text{g/m}^3$$

$$\text{Lead Concentration}_{\text{act.}} = \frac{700}{234} \times 10^3 = 2{,}990\ \mu\text{g/m}^3$$

$$\text{Lead Concentration}_{\text{std.}} = \frac{700}{233} \times 10^3 = 3{,}000\ \mu\text{g/m}^3$$

$$\text{Arsenic Concentration}_{\text{act.}} = \frac{550}{234} = 2.35\ \mu\text{g/m}^3$$

$$\text{Arsenic Concentration}_{\text{std.}} = \frac{550}{233} = 2.36\ \mu\text{g/m}^3$$

$$\text{Cadmium Concentration}_{\text{act.}} = \frac{4{,}600}{234} = 19.6\ \mu\text{g/m}^3$$

$$\text{Cadmium Concentration}_{\text{std.}} = \frac{4{,}600}{233} = 19.7\ \mu\text{g/m}^3$$

5. Particle density: There were 64 different samples from which density determination was attempted. This population of samples covered both Types 1 and 2 samples (see Table 3) and represented most sampling locations at both ASARCO sites--Glover, Missouri, and East Helena, Montana. In two cases (Samples 2013 and 3005) there was not sufficient sample.

---

[*] Results are given to three significant figures only.

Since there was no quantity determination by McCrone of each species in a sample, representative values were determined by an averaging technique from lead and arsenic mass concentration values determined by MRI on other samples taken at the same locations. This average value of lead and arsenic mass concentrations, M_o', was divided by the total particulate mass concentration value for the sample M_T', to give an adjustment factor K, or

$$K = \frac{M_o'}{M_T'} \quad . \tag{4}$$

The representative total species mass concentration, M_o, for a sample of the population of 62 analyzed by McCrone is determined by multiplying the K value for a sample by its total particulate mass concentration value, M_T, which was determined by MRI, or

$$M_o = KM_T \quad . \tag{5}$$

Now, having determined M_o, knowing M_T, and assuming $\delta_o = 1$,* the density of a sample is calculated from the following equation:

$$\delta_\rho = \frac{\bar{\delta}\, M_o}{M_T} + \frac{\delta_o\, (M_T - M_o)}{M_T} \tag{6}$$

or

$$\delta_\rho = \frac{\bar{\delta}\, M_o}{M_T} + \frac{(M_T - M_o)}{M_T} \quad . \tag{7}$$

where $\bar{\delta} = 0.01\, (\rho_1\delta_1 + \rho_2\delta_2 + \dots + \rho_n\delta_n)$ (8)

ρ_i = percent of a species in a sample as determined by McCrone (Table 26) and $i = 1, 2, \dots, n$ where $n = 10$

δ_i = handbook value of a species given by McCrone and $i = 1, 2, \dots, n$ where the species are: $\delta_1 = 11.34$ for Pb, $\delta_2 = 7.5$ for PbS, $\delta_3 = 6.2$ for $PbSO_4$, $\delta_4 = 5.61$ for ZnO, $\delta_5 = 4.1$ for ZnS, $\delta_6 = 2.71$ for $CaCO_3$, $\delta_7 = 2.87$ for As_2O_3, $\delta_8 = 2.96$ for $CaSO_4$, $\delta_9 = 8.15$ for CdO, and $\delta_{10} = 7.14$ for Zn .

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* A density of 1 was assumed for the material in a sample that was not that of the species identified (Table 26), since it was believed that most of this portion of the sample was fly ash and a density of 1 was representative of it.

An example is:

Given:

Location	Run	Total Conc.[a] ($\mu g/m^3$)	Pb Conc.[a] ($\mu g/m^3$)	As Conc.[a] ($\mu g/m^3$)	Cd Conc.[a] ($\mu g/m^3$)	(Pb+As+Cd) ($\mu g/m^3$)
1-Bottom	2	3,280	684	0.76	5.45	690
1-Bottom	3	8,340	2,740	2.44	23.50	2,766
1-Bottom	1	11,000	-	-	-	-

Densities:[b] $\delta_0 = 1$, $\delta_2 = 7.5$, $\delta_3 = 6.2$, $\delta_5 = 4.10$

Percentages:[b] $\rho_1 = 60$, $\rho_3 = 10$, $\rho_5 = 30$

---

[a] Actual conditions - Table 5.
[b] Table 26.

Determine: Density of sample (Filter No. 2004) of Location 1-bottom from Run 1

The average value of lead, arsenic, and cadmium concentrations from 1-bottom of Runs 2 and 3 is determined as follows:

$$M_o' = \frac{690 + 2,766}{2} = 1,728\ \mu g/m^3\ .$$

The average value of the total concentration of particulate from 1-bottom of Runs 2 and 3 is determined as follows:

$$M_T' = \frac{3,280 + 8,340}{2} = 5,810\ \mu g/m^3\ .$$

From Eq. (4), K is calculated ,

$$K = \frac{M_o'}{M_T} = \frac{1,728}{5,810} = 0.297\ .$$

The total mass of the sample (Filter No. 2006) of Location 1-bottom from Run 1 is:

$$M_T = 11,000\ \mu g/m^3\ .$$

Now, using Eq. (5),

$$M_o = KM_T = 0.297 \times 11{,}000 = 3{,}267 \ \mu g/m^3 \ .$$

Solving Eq. (8), $\bar{\delta}$ becomes,

$$\bar{\delta} = 0.01 \ (60 \times 7.5 + 10 \times 6.2 + 30 \times 4.1) = 6.35 \ .$$

Substituting $\delta_o = 1$, $\bar{\delta} = 6.35$, $M_T = 11{,}000$, and $M_o = 3{,}267$ into Eq. (7), the density of the particulate for the sample becomes:

$$\delta_\rho = \frac{6.35 \times 3{,}267}{11{,}000} + \frac{11{,}000 - 3{,}267}{11{,}000}$$

or

$$\delta_\rho = 1.89 + 0.703 = 2.59 \ .$$

6. Emission rate - total particulate, lead, and arsenic: The emission rates are calculated by using either Eqs. (9) or (10) given below, depending on the specific type of fugitive emission:

$$\text{Emission Rate } (\mu g/\text{min}) = \text{Conc. } (\mu g/m^3) \times \text{Flow (fpm)} \times \text{Area } (ft^2) \times 0.028317 \ \frac{m^3}{ft^3} \qquad (9)$$

where Concentration was calculated using Eq. (3).

Flow used was that measured by a hand-held velometer or the wind velocity measured by MRI's meteorological station if one were at the location, and if not, that measured by an ASARCO weather station.

Area is that from which there were emissions from the type source for which a sampling location represented (Section VI-C-1, and Appendix N).

0.028317 is the factor for converting ft^3 to m^3.

$$\text{Emission Rate (mg/min)} = \begin{bmatrix}\text{Cross-Sectional}\\ \text{Transport Area}\end{bmatrix} (\text{ft}^2) \times \begin{matrix}\text{Average Transport}\\ \text{Velocity}\end{matrix} (\text{ft/min}) \times \begin{bmatrix}\text{Average Particulate}\\ \text{Concentration Minus}\\ \text{Background Concentration}\end{bmatrix} (\text{mg/m}^3) \times 0.028317 \qquad (10)$$

where *Cross-sectional transport area* is the vertical profile of the fugitive source multiplied by a factor of $1 \leq k \leq 2$, where the value of k depends upon the relative location of the sampler to the source.

Average transport velocity is the flow as specified for Eq. (9).

Average particulate concentration minus background concentration is the concentration measured by the sampler that sampled the fugitive emissions from a source, and the background is the concentration determined from ambient samplers placed upwind from the fugitive source.

0.028317 is the factor for converting ft^3 to m^3.

Equation (9) was used for calculating emission rates (results are given in Table 6) at all locations except 4A, 5A, 6, 6N, and 6S at Glover, Missouri, and 23A, 24N, and 24S at East Helena, Montana. Locations 4A, 5A, and 23A provided only data on background particulate concentrations. Locations 6, 6N, and 6S also provided only background particulate concentrations because of the location of the samplers with regard to the transfer points and the fact that there was no visual indication of emissions. This latter point is substantiated by the fact that the ore was quite moist (approximately 15%). Location 23A was not actually intended to obtain emission data. Rather it was to provide supplemental information for ambient-air concentrations. Because of quite variable wind conditions, Locations 24N and 24S only provide data on ambient-air concentrations. These concentrations given in Table 5 are believed to be primarily ambient-air background concentrations because of the low emissions observed visibly during transfer operations.

Since there was only a small set of data from Locations 6, 6N, 6S, 24N, and 24S, and the wind conditions and surrounding terrain compounded this picture, no emission information was attainable. Therefore, Eq. (10) was not used.

An example of an emission calculation by Eq. (9) is:

Given:

Location	Run	Total Part. Conc.[a] (µg/m³)	Flow[b] (fpm)	Effective Area (sq ft)	Wind Dir. (deg.)	Wind Vel. (fpm)	Remarks
1-top	1	2,060	25 (v)	3,090	337	265	1-top is upper sampler of the vertical-profile sampler.
1-top	2	4,380	90	2,315	360	90	
1-top	3	6,740	67.5 (v)	3,090	135	175	
1-top	5	353	275 (v)	3,090	337	265	
1-bottom	1	11,000	25 (v)	1,540	337	265	1-bottom is lower sampler of the vertical-profile sampler.
1-bottom	2	3,280	90	2,315	360	90	
1-bottom	3	8,340	67.5 (v)	1,540	135	175	
1-bottom	5	447	275 (v)	1,540	337	265	
1	1	6,300	25 (v)	1,540	360	265	Location 1 is a HiVol positioned on the ground to sample at the same height as 1-bottom and nearby.
1	2	1,480	90	2,315	360	90	

---

[a] Actual conditions.

[b] The values with a (v) after them were taken by a hand-held velometer and the air flow was out of the building at the rates indicated.

Location	Run	Total Part. Conc.[a] (µg/m³)	Flow[b] (fpm)	Effective Area (sq ft)	Wind Dir. (deg.)	Wind Vel. (fpm)
2-north	1	3,330	125	945	337	265
2-north	2	11,500	125	945	360	90
2-north	3	2,140	125	945	135	175
2-north	4	17,200	125	945	157	265
2-north	5	14,100	125	945	337	210
2-south	1	2,920	225	485	337	265
2-south	2	5,180	225	485	360	90
2-south	3	3,100	225	485	135	175
2-south	4	5,970	225	485	157	265
2-south	5	8,160	225	485	337	210

---

[a] Actual conditions.

[b] The values given were taken by a hand-held velometer.

Determine: Emission Rate of Total Particulate from Sinter Building Under Actual Conditions

The total particulate emissions will be the sum of those from Locations 1 and 2.

First, however, an emission value is determined by using Eq. (9) for each sample of each run at a location. Then, an average emissions value is determined for each location (1 and 2), and these average values are then summed arithmetically to give a representative emission value for the sinter building.

An MRI weather station was located approximately 60 ft to the north of Location 1, and the values given in Columns 6 and 7 of the above tabulations are wind direction and wind velocity measured by this station. The vertical-profile sampler also contained anemometers--one for the top sampler and one for the bottom sampler. In the absence of a velometer reading during a run, these anemometer readings were used as the flow reading.

Generally, wind velocity and wind direction were variable. Consequently, the values shown in the tabulation are weighted averages. It is believed that temperature differences (building and outdoor ambient) and the geometry of the building structures caused micrometeorological air movements, as well as other confounding situations at the building opening when the sampling took place. Because of these two factors, the wind data shown are not believed to be highly significant. Consequently, the velometer readings, although variable also, were selected as the values to be used in the calculations.

Since Run 2 gave flow into the building, the 1-top, 1-bottom, and 1 locations of Run 2 are excluded from the set of data, and the average emission from the locations is determined as follows, using Eq. (9):

Location	Run	Emission Rate, E,[a] in mg/min	
1-top	1	$E = 2{,}060 \times 25 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 4,500
1-top	3	$E = 6{,}740 \times 67.5 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 39,800
1-top	5	$E = 353 \times 275 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 8,490
1-bottom	1	$E = 11{,}000 \times 25 \times 1{,}540 \times 0.028317 \times 10^{-3}$	= 12,000
1-bottom	3	$E = 8{,}340 \times 67.5 \times 1{,}540 \times 0.028317 \times 10^{-3}$	= 24,600
1-bottom	5	$E = 447 \times 275 \times 1{,}540 \times 0.028317 \times 10^{-3}$	= 5,360
1	1	$E = 6{,}300 \times 25 \times 1{,}540 \times 0.028317 \times 10^{-3}$	= 6,860
		E_{Total}	101,610
		$E_{Average}$	14,500

---

[a] "E" values rounded to three significant figures.

The average emission rate, E_1 average , for Location 1 (1-top, 1-bottom, and 1) is calculated by summing the seven emission rates in the tabulation above and dividing by 7 to give:

$$E_{1\ \text{avg.}} = \frac{4{,}500 + 39{,}800 + 8{,}490 + 12{,}000 + 24{,}600 + 5{,}360 + 6{,}860}{7} =$$

$$\frac{101{,}610}{7} = 14{,}500 \text{ mg/min} .$$

The average emission rate, $E_{2\ \text{avg.}}$, for Location 2 (2-north and 2-south) is calculated similarly:

Location	Run	Emission Rate, E,[a/] in mg/min	
2-north	1	$E = 3{,}330 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 11,100
2-north	2	$E = 11{,}500 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 38,400
2-north	3	$E = 2{,}140 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 7,150
2-north	4	$E = 17{,}200 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 57,500
2-north	5	$E = 14{,}100 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 47,200
2-south	1	$E = 2{,}920 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 9,020
2-south	2	$E = 5{,}180 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 16,000
2-south	3	$E = 3{,}100 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 9,580
2-south	4	$E = 5{,}970 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 18,400
2-south	5	$E = 8{,}160 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 25,200
		E_{Total}	= 240,000
		E_{Average}	= 24,000

[a/] "E" values rounded to three significant figures.

The average emission rate, $E_{2\ \text{avg.}}$, for Location 2 (2-north and 2-south) is:

$$E_{2\ \text{avg.}} = \frac{240{,}000}{10} = 24{,}000 \text{ mg/min.}$$

Therefore, the average total particulate emission rate from the sinter building is:

$$E_{T\ \text{avg.}} = E_{1\ \text{avg.}} + E_{2\ \text{avg.}} = 14{,}500 + 24{,}000 = 38{,}500 \text{ mg/min}$$

or

$$E_{T\ \text{avg.}} = 38.5 \text{ g/min} .$$

The lead, arsenic, and cadmium emissions (standard conditions) are calculated similarly using their respective values from Table 5.

To find emission rates under standard conditions, the standard conditions concentration values of Table 5 would be used in place of the actual conditions concentration values from the same table. These calculations and results are given in Appendix N.

TABLE 3

SAMPLING AND CLIMATIC CONDITIONS DATA

Sampling Data														Climatic Conditions			
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c]		Filter No.	Size Range (μ)	Sampler Rate (cfm)	Air Flow[d] (fpm)	Effective Area[e] (ft^2)	Volume[f]		Wind Velocity[g] (fpm)	Wind Direction[g] (degrees)	Temperature (°F)	Barometric Pressure (in. Hg)
					Set	Type						Act. Cond. (m^3)	Std. Cond. (m^3)				
1	1-Stage 5	7-8-76			1, 3	2	3000	0.31-0.59	40	25	1,540	226	224	265	337	93.5	30.46
	4				1, 3	2	3001	0.59-0.95	40	25	1,540	226	224	265	337	93.5	30.46
	3				1, 3	2	3002	0.95-1.9	40	25	1,540	226	224	265	337	93.5	30.46
	2				1, 3	2	3003	1.9-4.6	40	25	1,540	226	224	265	337	93.5	30.46
	1				1, 3	2	3004	> 4.6	40	25	1,540	226	224	265	337	93.5	30.46
	Backup				1, 3	1	2007	< 0.31	40	25	1,540	226	224	265	337	93.5	30.46
	Total		1250-1610	200	-	-	-	-	40	25	1,540	226	224	265	337	93.5	30.46
	1-Top		0827-0830 1247-1605	3 + 198	1, 2	1	2003	-	36	25	3,090	205	202	265	337	93.5	30.46
	1-Bottom		0827-0830 1247-1605	3 + 198	1, 4	1	2004	-	34.75	25	1,540	198	195	265	337	93.5	30.46
	2-North		1300-1632	212	1, 2	1	2001	-	42	125	945	252	249	265	337	93.5	30.46
	2-South		1310-1640	210	1, 2	1	2002	-	37	225	485	220	217	265	337	93.5	30.46
	3		1303-1530	147	1, 2	1	2005	-	53	0	2,035	221	218	Calm	-	93.7	30.46
	3A		0317-0322 0333-0338 0424-0429	15	1, 4	1	2006	-	52	215	6,430	22.1	21.8	215	57	93.7	30.46
2	1-Stage 5	7-8-76 to 7-9-76			1, 4	2	3010	0.31-0.59	40	90	2,315	959	987	90	360 Except for 180 1800-1430	71.5	30.48
	4				1, 4	2	3009	0.59-0.95	40	90	2,315	959	987	90		71.5	30.48
	3				1, 4	2	3008	0.95-1.9	40	90	2,315	959	987	90		71.5	30.48
	2				1, 4	2	3007	1.9-4.6	40	90	2,315	959	987	90		71.5	30.48
	1				1, 4	2	3006	> 4.6	40	90	2,315	959	987	90		71.5	30.48
	Backup				1, 4	1	2015	< 0.31	40	90	2,315	959	987	90		71.5	30.48
	Total		1715-0722	847	-	-	-	-	40	90	2,315	959	987	90		71.5	30.48
	1-Top		1627-0714	887	1, 2	1	2009	-	37.25	90	2,315	936	960	90		72.9	30.48
	1-Bottom		1627-0714	887	1, 2	1	2010	-	37.25	90	2,315	936	960	90		72.9	30.48
	2-North		1635-0725	890	1, 2	1	2012	-	18	125	945	454	466	90		72.9	30.48
	2-South		1640-0730	890	1, 2	1	2011	-	40	225	485	1,010	1,030	90	↓	72.9	30.48
	3		1650-~1930	160	1, 4	1	2013	-	53	245	2,035	240	239	245	180	88.2	30.46
	3A		1700-0800	900	1, 2	1	2014	-	50	190	6,430	1,270	1,310	190	113	71.9	30.48
3	1-Top	7-9-76	0840-1222	222	1, 2	1	2020	-	37.25	67.5	3,090	234	233	175	135	90.3	30.54
	1-Bottom		0840-1222	222	1, 2	1	2019	-	37.25	67.5	1,540	234	233	175	135	90.3	30.54
	2N-Stage 5				1, 2	2	3015	0.38-0.71	27	125	945	195	194	175	135	91.4	30.54
	4				1, 2	2	3014	0.71-1.15	27	125	945	195	194	175	135	91.4	30.54
	3				1, 2	2	3013	1.15-2.3	27	125	945	195	194	175	135	91.4	30.54
	2				1, 2	2	3012	2.3-5.6	27	125	945	195	194	175	135	91.4	30.54
	1				1, 2	2	3011	> 5.6	27	125	945	195	194	175	135	91.4	30.54
	Backup				1, 2	1	2021	< 0.38	27	125	945	195	194	175	135	91.4	30.54
	Total		1100-1515	255	-	-	-	-	27	125	945	195	194	175	135	91.4	30.54

TABLE 3 (Continued)

			Sampling Data											Climatic Conditions			
Run No.a/	Locationb/	Date	Time	Sampling Period (min)	Samplesc/ Set	Samplesc/ Type	Filter No.	Size Range (µ)	Sampler Rate (cfm)	Air Flowd/ (fpm)	Effective Areae/ (ft²)	Volumef/ Act. Cond. (m³)	Volumef/ Std. Cond. (m³)	Wind Velocityg/ (fpm)	Wind Directiong/ (degrees)	Temperature (°F)	Barometric Pressure (in. Hg)
3	2-South	7-9-76	0730-1505	455	1, 4	1	2016	-	38	225	485	490	488	175	135	86.3	30.54
	3		0730-1545	495	1, 2	1	2017	-	53	265	2,035	743	741	265	180	89.2	30.54
	3A		9, 5-min intervalsh/	45	1, 2	1	2018	-	50	500	6,430	63.7	63.6	500	23	89.2	30.54
4	2-North	7-9-76 to 7-10-76	1535-0905	1,050	1, 4	1	2025	-	11	125	945	327	336	265	157	73.1	30.49
	2-South		1540-0905	1,045	1, 2	1	2022	-	38	225	485	1,120	1,150	265	157	73.1	30.49
	3-Stage 5		1547-0900	1,033	1, 2	2	3021	0.31-0.59	40	265	2,035	1,170	1,200	265	135	73.1	30.49
	4		1547-0900	1,033	1, 2	2	3020	0.59-0.95	40	265	2,035	1,170	1,200	265	135	73.1	30.49
	3		1547-0900	1,033	1, 2	2	3019	0.95-1.9	40	265	2,035	1,170	1,200	265	135	73.1	30.49
	2		1547-0900	1,033	1, 2	2	3018	1.9-4.6	40	265	2,035	1,170	1,200	265	135	73.1	30.49
	1		1547-0900	1,033	1, 2	2	3017	> 4.6	40	265	2,035	1,170	1,200	265	135	73.1	30.49
	Backup		1547-0900	1,033	1, 4	1	2026	< 0.31	40	265	2,035	1,170	1,200	265	135	73.1	30.49
	Total		1547-0900	1,033	-	-	-	-	40	265	-2,035	1,170	1,200	265	135	73.1	30.49
	3		1540-0900	1,044	1, 2	1	2023	-	53	265	2,035	1,560	1,580	265	135	80.8	30.49
	3A		1555-0900	1,025	1, 2	1	2024	-	53	360	6,430	1,540	1,560	360	152	80.8	30.49
5	1-Top	7-12-76	0745-1330	345	1, 4	1	2031	-	37.25	275	3,090	364	361	360	337	90.9	30.43
	1-Bottom		0745-1330	345	1, 3	1	2032	-	37.25	275	1,540	364	361	360	337	90.9	30.43
	2-North		0830-1415	345	1, 3	1	2027	-	13	125	945	127	126	210	337	91.4	30.43
	2-South		0830-1415	345	1, 2	1	2028	-	39	225	485	381	377	210	337	91.4	30.43
	3		0900-1500	360	1, 3	1	2033	-	52	175	2,035	547	540	175	360	93.2	30.42
	3A		0845-1500	375	1, 2	1	2030	-	51.5	450	6,430	530	524	450	327	93.2	30.42
6	4	7-12-76 to 7-13-76	1600-0915	1,035	1, 4	1	2035	-	50	10	650	1,460	1,490	Calm	-	76.6	30.39
	5		1600-0915	1,035	1, 2	1	2036	-	58	165	1,190	1,700	1,730	165	225	76.6	30.39
7	4	7-13-76	1300-1545	165	1, 2	1	2037	-	57	10	650	266	261	Calm	-	96.8	30.42
	5		1300-1545	165	1, 4	1	2038	-	57	310	1,190	266	261	310	135	96.8	30.42
8	4-Stage 5	7-13-76 to 7-14-76	1600-0730	930	1, 2	2	3027	0.33-0.63	35	10	650	922	932	Calm	-	79.5	30.46
	4		1600-0730	930	1, 2	2	3028	0.63-1.0	35	10	650	922	932	Calm	-	79.5	30.46
	3		1600-0730	930	1, 2	2	3029	1.0-2.03	35	10	650	922	932	Calm	-	79.5	30.46
	2		1600-0730	930	1, 2	2	3030	2.03-4.9	35	10	650	922	932	Calm	-	79.5	30.46
	1		1600-0730	930	1, 2	2	3031	> 4.9	35	10	650	922	932	Calm	-	79.5	30.46
	Backup		1600-0730	930	1, 2	1	2045	< 0.33	35	10	650	922	932	Calm	-	79.5	30.46
	Total		1600-0730	930	-	-	-	-	35	10	650	922	932	Calm	-	79.5	30.46
	5		1600-0730	930	1, 3	1	2042	-	58	230	1,190	1,530	1,540	230	324	79.5	30.46
	6-North		1400-1400	1,440	1, 4	1	2040	-	54	200	Amb.	2,200	2,200	200*	225*	85.3	30.42
	6-South		1400-1400	1,440	1, 3	1	2039	-	48	200	Amb.	1,960	1,960	200*	225*	85.3	30.42
	6-Overpass		1400-1400	1,440	1, 2	1	2041	-	48	200	Amb.	1,960	1,960	200*	225*	85.3	30.42

TABLE 3 (Continued)

Sampling Data														Climatic Conditions			
Run No. a/	Location b/	Date	Time	Sampling Period (min)	Samples c/ Set	Samples c/ Type	Filter No.	Size Range (μ)	Sampler Rate (cfm)	Air Flow d/ (fpm)	Effective Area e/ (ft^2)	Volume f/ Act. Cond. (m^3)	Volume f/ Std. Cond. (m^3)	Wind Velocity g/ (fpm)	Wind Direction g/ (degrees)	Temperature (°F)	Barometric Pressure (in. Hg)
9	4	7-14-76	0725-1245	320	1, 2	1	2044	-	57	10	650	516	512	Calm	-	91.2	30.44
	5	7-14-76	0725-1245	315	1, 2	1	2043	-	59	360	1,190	526	522	360	176	91.2	30.44
10	4	7-14-76	1600-0720	920	1, 2	1	2052	-	52	10	650	1,350	1,380	Calm	-	78.2	30.44
	5-Stage 5	to	1300-1600	180	1, 2	2	3032	0.31-0.59	40	510	1,190	204	199	510	225	98.5	30.43
	4	7-15-76	1300-1600	180	1, 2	2	3033	0.59-0.95	40	510	1,190	204	199	510	225	98.5	30.43
	3		1300-1600	180	1, 2	2	3034	0.95-1.9	40	510	1,190	204	199	510	225	98.5	30.43
	2		1300-1600	180	1, 2	2	3035	1.9-4.6	40	510	1,190	204	199	510	225	98.5	30.43
	1		1300-1600	180	1, 2	2	3036	> 4.6	40	510	1,190	204	199	510	225	98.5	30.43
	Backup		1300-1600	180	1, 2	1	2046	< 0.31	40	510	1,190	204	199	510	225	98.5	30.43
	Total		1300-1600	180	-	-	-	-	40	510	1,190	204	199	510	225	98.5	30.43
	5		1600-0730	930	1, 2	1	2053	-	59	165	1,190	1,550	1,560	165	360	78.2	30.44
	6-North		1400-0800	1,080	1, 2	1	2048	-	48	160	Amb.	1,470	1,490	160*	180*	80.2	30.44
	6-South		1400-0800	1,080	1, 2	1	2049	-	49	160	Amb.	1,500	1,520	160*	180*	80.2	30.44
	6-Overpass		1400-0800	1,080	1, 2	1	2050	-	51	160	Amb.	1,560	1,580	160*	180*	80.2	30.44
11	4	7-14-76	1230-1600	210	1, 3	1	2047	-	57	10	650	339	332	Calm	-	98.3	30.43
12	4A	7-15-76	0720-1300	340	1, 4	1	2057	-	61	300	Amb.	587	593	300	225	82.1	30.50
	5A		0730-1300	330	1, 4	1	2055	-	58	245	Amb.	542	547	245	247	82.1	30.50
	6N-Stage 5		1245-1430	105	1, 2	2	3037	0.33-0.63	35	350	Amb.	104	105	350*	225*	82.5	30.50
	4		1245-1430	105	1, 2	2	3038	0.63-1.0	35	350	Amb.	104	105	350*	225*	82.5	30.50
	3		1245-1430	105	1, 2	2	3039	1.0-2.03	35	350	Amb.	104	105	350*	225*	82.5	30.50
	2		1245-1430	105	1, 2	2	3040	2.03-4.9	35	350	Amb.	104	105	350*	225*	82.5	30.50
	1		1245-1430	105	1, 2	2	3041	> 4.9	35	350	Amb.	104	105	350*	225*	82.5	30.50
	Backup		1245-1430	105	1, 2	1	2054	< 0.33	35	350	Amb.	104	105	350*	225*	82.5	30.50
	Total		1245-1430	105	-	1	-	-	35	350	Amb.	104	105	350*	225*	82.5	30.50
	6-North		0800-1245	285	1, 2	1	2059	-	54	255	Amb.	436	439	255*	225*	83.8	30.50
	6-South		0800-1430	390	1, 2	1	2060	-	48	255	Amb.	530	534	255*	225*	83.8	30.50
	6-Overpass		0800-1415	375	1, 2	1	2056	-	51	255	Amb.	542	545	255*	225*	83.8	30.50
20	11	7-22-76	1530-0744	974	1, 2	1	2061	-	33	275	240	910	923	620	240*	70.7	30.00
	12	to	1530-0754	994	1, 2	1	2062	-	33	275	1.8	929	942	620	240*	70.7	30.00
	13	7-23-76	1550-0738	948	1, 2	1	2063	-	29	275	114	778	790	620	240*	70.7	30.00
	14		1520-0740	980	1, 2	1	2064	-	45	275	114	1,250	1,270	620	240*	70.7	30.00
	15		1530-0800	990	1, 2	1	2065	-	45	275	48	1,260	1,280	620	240*	70.7	30.00
	16		1515-0730	995	1, 2	1	2066	-	37	50	64	1,040	1,060	620	240*	70.7	30.00

TABLE 3 (Continued)

				Sampling Data										Climatic Conditions			
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Size Range (μ)	Sampler Rate (cfm)	Air Flow[d] (fpm)	Effective Area[e] (ft²)	Volume[f] Act. Cond. (m³)	Volume[f] Std. Cond. (m³)	Wind Velocity[g] (fpm)	Wind Direction[g] (degrees)	Temperature (°F)	Barometric Pressure (in. Hg)
21	11-Stage 5	7-23-76	0752-1510	438	1, 3	2	3046	0.40-0.76	24	225	240	298	299	705	Var.*	76.3	30.03
	4		0752-1510	438	1, 3	2	3045	0.76-1.2	24	225	240	298	299	705	Var.*	76.3	30.03
	3		0752-1510	438	1, 3	2	3044	1.2-2.4	24	225	240	298	299	705	Var.*	76.3	30.03
	2		0752-1510	438	1, 3	2	3043	2.4-5.9	24	225	240	298	299	705	Var.*	76.3	30.03
	1		0752-1510	438	1, 3	2	3042	> 5.9	24	225	240	298	299	705	Var.*	76.3	30.03
	Backup		0752-1510	438	1, 3	1	2069	< 0.40	24	225	240	298	299	705	Var.*	76.3	30.03
	Total		0752-1510	438	-	-	-	-	24	225	240	298	299	705	Var.*	76.3	30.03
	12		0807-1520	433	1, 4	1	2070	-	44	75	1.8	540	540	705	Var.*	76.3	30.03
	13-Stage 5		0742-1540	478	1, 4	2	3051	0.31-0.59	39	270	114	528	529	705	Var.*	77.5	30.03
	4		0742-1540	478	1, 4	2	3050	0.59-0.95	39	270	114	528	529	705	Var.*	77.5	30.03
	3		0742-1540	478	1, 4	2	3049	0.95-1.9	39	270	114	528	529	705	Var.*	77.5	30.03
	2		0742-1540	478	1, 4	2	3048	1.9-4.6	39	270	114	528	529	705	Var.*	77.5	30.03
	1		0742-1540	478	1, 4	2	3047	> 4.6	39	270	114	528	529	705	Var.*	77.5	30.03
	Backup		0742-1540	478	1, 4	1	2071	< 0.31	39	270	114	528	529	705	Var.*	77.5	30.03
	Total		0742-1540	478	-	-	-	-	39	270	114	528	529	705	Var.*	77.5	30.03
	14		0750-1526	456	1, 4	1	2072	-	39	100	114	736	738	705	Var.*	77.5	30.03
	15		0800-1508	428	1, 4	1	2073	-	57	150	48	667	670	705	Var.*	76.3	30.03
	16		0740-1519	459	1, 4	1	2074	-	55	250	64	481	483	705	Var.*	76.3	30.03
22	11	7-23-76	1515-0740	985	1, 3	1	2077	-	37	100	240	1,060	1,060	995	192*	79.2	30.04
	12	to	1530-0745	975	1, 2	1	2078	-	38	300	1.8	1,210	1,220	995	192*	79.2	30.04
	13	7-24-76	1540-0750	970	1, 2	1	2079	-	44	300	114	1,040	1,040	995	192*	79.2	30.04
	14A		1547-0735	948	1, 2	1	2075	-	38	50	74	1,290	1,290	995	192*	79.2	30.04
	15		1514-0730	976	1, 2	1	2076	-	48	250	48	1,220	1,220	995	192*	79.2	30.04
	16		1523-0732	969	1, 2	1	2080	-	44	300	64	1,070	1,070	995	192*	79.2	30.04
23	21	7-26-76	1005-1445	280	1, 4	1	2081	-	39	440	129	492	489	440	315	77.9	29.81
	22		1220-1450	150	1, 4	1	2086	-	62	50	180	234	230	840*	305*	84.4	29.81
	23		1030-1457	267	1, 4	1	2082	-	55	475	214	355	353	680	305*	79.2	29.81
	23A		1315-1505	110	1, 4	1	2087	-	42.5	1,135	Amb.	132	130	1,135*	292*	85.6	29.81
	24-North	7-26-76	1035-1515	280	1, 4	1	2083	-	53	210	Amb.	420	417	210	0900-1130 360	79.2	29.81
	24-South		1040-1520	280	1, 4	1	2084	-	57	210	Amb.	452	448	210	1130-1630 Variable	79.2	29.81
24	23	7-26-76	1501-0750	1,009	1, 2	1	2089	-	43	500	214	1,230	1,230	1,350	270*	76.6	29.89
		to															
	23A	7-27-76	1510-0800	1,010	1, 2	1	2090	-	40	1,320	Amb.	1,140	1,140	1,320*	267*	76.6	29.89
25	21	7-27-76	0730-1425	415	1, 2	1	2096	-	53	970	129	623	629	970	315	72.5	29.96
	22		0735-1430	415	1, 2	1	2097	-	57	50	180	670	676	1,815*	285*	72.5	29.96
	23		0753-1045	172	1, 2	1	2098	-	41	400	214	200	202	1,655	288*	70.5	29.96
	23A		0802-1100	178	1, 3	1	2099	-	39	1,655	Amb.	197	199	1,655*	286*	70.5	29.96
	24-North		0820-1500	400	1, 3	1	2100	-	46	465	Amb.	521	525	465	Variable	73.4	29.96
	24-South		0810-1510	420	1, 3	1	2101	-	54	465	Amb.	642	647	465	Variable	73.4	29.96

TABLE 3 (Continued)

Sampling Data														Climatic Conditions			
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Size Range (μ)	Sampler Rate (cfm)	Air Flow[d] (fpm)	Effective Area[e] (ft^2)	Volume[f] Act. Cond. (m^3)	Volume[f] Std. Cond. (m^3)	Wind Velocity[g] (fpm)	Wind Direction[g] (degrees)	Temperature (°F)	Barometric Pressure (in. Hg)
26	23-Stage 5		1055-1445	410	1, 4	2	3056	0.31-0.59	39	450	214	453	455	1,935	273*	75.0	29.96
	4		1055-1445	410	1, 4	2	3055	0.59-0.95	39	450	214	453	455	1,935	273*	75.0	29.96
	3		1055-1445	410	1, 4	2	3054	0.95-1.9	39	450	214	453	455	1,935	273*	75.0	29.96
	2		1055-1445	410	1, 4	2	3053	1.9-4.6	39	450	214	453	455	1,935	273*	75.0	29.96
	1		1055-1445	410	1, 4	2	3052	> 4.6	39	450	214	543	455	1,935	273*	75.0	29.96
	Backup		1055-1445	410	1, 4	1	2091	< 0.31	39	450	214	453	455	1,935	273*	75.0	
	Total		1055-1445	410	-	-	-	-	39	450	214	453	455	1,935	273*	75.0	29.96
	23A-Stage 5		1100-1450	230	1, 2	2	3061	0.33-0.63	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
	4		1100-1450	230	1, 2	2	3060	0.63-1.0	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
	3		1100-1450	230	1, 2	2	3059	1.0-2.03	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
	2		1100-1450	230	1, 2	2	3058	2.03-4.9	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
	1		1100-1450	230	1, 2	2	3057	> 4.9	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
	Backup		1100-1450	230	1, 2	1	2097	< 0.33	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
	Total		1100-1450	230	1, 2	-	-	-	37	1,935	Amb.	241	242	1,935*	273*	75.0	29.96
27	17	7-27-76	1530-0930	1,080	1, 2	1	2095	-	40	975	600	1,220	1,250	975*	315*	63.3	29.90
	18	to	1530-0920	1,070	1, 2	1	2102	-	40	975	600	1,210	1,240	975*	315*	63.3	29.90
	23	7-28-76	1447-0725	998	1, 2	1	2093	-	44	400	214	1,240	1,270	1,120	260*	64.8	29.90
	23A		1455-0700	1,005	1, 2	1	2094	-	43	1,055	Amb.	1,220	1,250	1,055*	260*	64.8	29.90
28	17	7-28-76	0935-1505	330	1, 4	1	2106	-	42	810	600	392	395	810*	209*	72.7	29.85
	18		0925-1510	345	1, 4	1	2107	-	44	810	600	430	432	810*	225*	72.7	29.85
	19		0850-1530	400	1, 4	1	2103	-	41	100	480	464	468	820	35*	72.1	29.85
	20		0900-1530	390	1, 4	1	2104	-	38	150	30	420	422	820	35*	72.1	29.85
29	17-Stage 5	7-28-76	1515-0745	990	1, 3	2	3066	0.31-0.59	39	975	600	1,090	1,110	975*	230*	67.1	29.82
	4	to	1515-0745	990	1, 3	2	3065	0.59-0.95	39	975	600	1,090	1,110	975	230	67.1	29.82
	3	7-29-76	1515-0745	990	1, 3	2	3064	0.95-1.9	39	975	600	1,090	1,110	975	230	67.1	29.82
	2		1515-0745	990	1, 3	2	3063	1.9-4.6	39	975	600	1,090	1,110	975	230	67.1	29.82
	1		1515-0745	990	1, 3	2	3062	> 4.6	39	975	600	1,090	1,110	975	230	67.1	29.82
	Backup		1515-0745	990	1, 3	1	2108	< 0.31	39	975	600	1,090	1,110	975	230	67.1	29.82
	Total		1515-0745	990	-	-	-	-	39	975	600	1,090	1,110	975	230	67.1	29.82
	18-Stage 5		1520-0740	980	1, 4	2	3071	0.33-0.63	35	975	600	971	986	975*	230*	67.1	29.82
	4		1520-0740	980	1, 4	2	3070	0.63-1.0	35	975	600	971	986	975	230	67.1	29.82
	3		1520-0740	980	1, 4	2	3069	1.0-2.03	35	975	600	971	986	975	230	67.1	29.82
	2		1520-0740	980	1, 4	2	3068	2.03-4.9	35	975	600	971	986	975	230	67.1	29.82
	1		1520-0740	980	1, 4	2	3067	> 4.9	35	975	600	971	986	975	230	67.1	29.82
	Backup		1520-0740	980	1, 4	1	2109	< 0.33	35	975	600	971	986	975	230	67.1	29.82
	Total		1520-0740	980	-	-	-	-	35	975	600	971	986	975*	230*	67.1	29.82
	19		1530-0810	1,000	1, 2	1	2110	-	27	100	480	765	777	915	270*	66.6	29.82
	20		1535-0815	1,000	1, 2	1	2111	-	16	150	30	453	460	915	270*	66.6	29.82
30	17	7-29-76	0747-1035	168	1, 2	1	2112	-	45	420	600	214	220	420*	322*	59.0	29.78
	18		0745-1050	185	1, 3	1	2113	-	44	420	600	230	237	420*	322*	59.0	29.78
	19		0815-1510	415	1, 2	1	2114	-	35	100	480	411	424	510	345	57.9	29.78
	20		0817-1520	423	1, 2	1	2115	-	32	150	30	383	396	510	345	57.9	29.78

TABLE 3 (Concluded)

				Sampling Data											Climatic Conditions			
													Volume f/					
Run No. a/	Location b/	Date	Time	Sampling Period (min)	Samples c/ Set	Samples c/ Type	Filter No.	Size Range (μ)	Sampler Rate (cfm)	Air Flow d/ (fpm)	Effective Area e/ (ft²)	Act. Cond. (m³)	Std. Cond. (m³)	Wind Velocity g/ (fpm)	Wind Direction g/ (degrees)	Temperature (°F)	Barometric Pressure (in. Hg)
31	17-Stage 5	7-29-76	1040-1455	255	1, 4	2	3006	0.33-0.63	36	580	600	260	259	580*	360*	75.7	29.78
	4		1040-1455	255	1, 4	2	3085	0.63-1.0	36	580	600	260	259	580	360	75.7	29.78
	3		1040-1455	255	1, 4	2	3084	1.0-2.03	36	580	600	260	259	580	360	75.7	29.78
	2		1040-1455	255	1, 4	2	3083	2.03-4.9	36	580	600	260	259	580	360	75.7	29.78
	1		1040-1455	255	1, 4	2	3082	> 4.9	36	580	600	260	259	580	360	75.7	29.78
	Backup		1040-1455	255	1, 4	1	2117	< 0.33	36	580	600	260	259	580	360	75.7	29.78
	Total		1040-1455	255	-	-	-	-	36	580	600	260	259	580	360	75.7	29.78
	18-Stage 5		1055-1500	245	1, 3	2	3081	0.33-0.63	34	580	600	236	235	580*	360*	75.7	29.78
	4		1055-1500	245	1, 3	2	3080	0.63-1.0	34	580	600	236	235	580	360	75.7	29.78
	3		1055-1500	245	1, 3	2	3079	1.0-2.03	34	580	600	236	235	580	360	75.7	29.78
	2		1055-1500	245	1, 3	2	3078	2.03-4.9	34	580	600	236	235	580	360	75.7	29.78
	1		1055-1500	245	1, 3	2	3077	> 4.9	34	580	600	236	235	580	360	75.7	29.78
	Backup		1055-1500	245	1, 3	1	2118	< 0.33	34	580	600	236	235	580	360	75.7	29.78
	Total		1055-1500	245	-	-	-	-	34	580	600	236	235	580	360	75.7	29.78
32	17	7-29-76	1500-0725	985	1, 2	1	2121	-	28	1,125	600	781	789	1,125*	275*	68.9	29.78
	18	to	1505-0730	985	1, 2	1	2122	-	19	1,125	600	530	536	1,125*	275*	68.9	29.78
	19	7-30-76	1515-0740	985	1, 2	1	2119	-	22	100	480	614	620	1,125	275*	68.9	29.78
	20		1520-0745	985	1, 2	1	2120	-	21	150	30	586	592	1,125	275*	68.9	29.78
33	17	7-30-76	0730-1340	370	1, 2	1	2123	-	37	535	600	388	399	535*	338*	63.7	30.00
	18		0735-1340	365	1, 2	1	2124	-	32	535	600	331	340	535*	338*	63.7	30.00
	19-Stage 5		0740-1400	380	1, 2	2	3101	0.31-0.59	41	100	480	441	454	535	340*	63.7	30.00
	4		0740-1400	380	1, 2	2	3100	0.59-0.95	41	100	480	441	454	535	340	63.7	30.00
	3		0740-1400	380	1, 2	2	3099	0.95-1.9	41	100	480	441	454	535	340	63.7	30.00
	2		0740-1400	380	1, 2	2	3098	1.9-4.6	41	100	480	441	454	535	340	63.7	30.00
	1		0740-1400	380	1, 2	2	3097	> 4.6	41	100	480	441	454	535	340	63.7	30.00
	Backup		0740-1400	380	1, 2	1	2125	< 0.31	41	100	480	441	454	835	340	63.7	30.00
	Total		0740-1400	380	-	-	-	-	41	100	480	441	454	535	340*	63.7	30.00
	20-Stage 5		0750-1355	365	1, 4	2	3091	0.33-0.63	34	150	30	351	361	535	340	63.7	30.00
	4		0750-1355	365	1, 4	2	3090	0.63-1.0	34	150	30	351	361	535	340	63.7	30.00
	3		0750-1355	365	1, 4	2	3089	1.0-2.03	34	150	30	351	361	535	340	63.7	30.00
	2		0750-1355	365	1, 4	2	3088	2.03-4.9	34	150	30	351	361	535	340	63.7	30.00
	1		0750-1355	365	1, 4	2	3087	> 4.9	34	150	30	351	361	535	340	63.7	30.00
	Backup		0750-1355	365	1, 4	1	2126	< 0.33	34	150	30	351	361	535	340	63.7	30.00
	Total		0750-1355	365	-	-	-	-	34	150	30	351	361	535	340	63.7	30.00

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a/ Runs 1 through 12 were at Glover, Missouri. Runs 20 through 33 were at East Helena, Montana. There were no runs 13 through 19.

b/ See Figures 1 and 2. Location 1 had three sampling points. Two (1-Top and 1-Bottom) were on the vertical profile sampler, and one was a HiVol positioned on the ground at the same height as 1-Bottom.

c/ Sets 1 and 2 were samples analyzed by MRI. Set 3 was analyzed by Physical Electronic Industries in Minneapolis; and Set 4 was analyzed by Walter C. McCrone Associates, Inc., in Chicago. Type 1 are 8 in. x 10 in., glass-fiber filters used in HiVol samplers. Type 2 are 4 in. x 5 in., glass-fiber filters used in the Sierra 5-Stage impactor, which in turn was used in HiVol samplers or in MRI's vertical-profile sampling apparatus.

d/ This is the velocity of the air that constitutes the fugitive emission.

e/ The effective area is that area through which the fugitive emissions flow, adjusted for two-dimensional particle distribution profiles at the area.

f/ Volume of air sampled during the sampling period. Standard conditions are 77°F and 29.92 in.

g/ The values with an asterisk after them are data from ASARCO weather station at the site.

h/ Test periods for Location 3A of Run 3 are 0800-0805, 0846-0851, 0935-0940, 1011-1016, 1100-1105, 1135-1140, 1339-1344, 1439-1444, 1530-1555.

TABLE 4

TOTAL PARTICULATE AND ELEMENT (PB, AS, AND CD) MASS AND PARTICULATE DENSITY

Sampling Data								Mass[d]				
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Mass (g)	Pb Weight (mg)	As Weight (μg)	Cd Weight (μg)	Particulate Density[e]
1	1-Stage 5	7-8-76			1,3	2	3000	0.04820	-	-	-	-
	4				1,3	2	3001	0.06290	-	-	-	-
	3				1,3	2	3002	0.05120	-	-	-	-
	2				1,3	2	3003	0.07880	-	-	-	-
	1				1,3	2	3004	0.58330	-	-	-	-
	Backup				1,3	1	2007	0.60180	-	-	-	-
	Total		1250-1610	200	-	-		1.42620	-	-	-	-
	1-Top		0827-0830	3 +								
			1247-1605	198	1,2	1	2003	0.42290	190	97	890	-
	1-Bottom		0827-0830	3 +								
			1247-1605	198	1,4	1	2004	2.17610	-	-	-	2.59
	2-North		1300-1632	212	1,2	1	2001	0.83980	500	240	5,300	-
	2-South		1310-1640	210	1,2	1	2002	0.64220	340	200	1,300	-
	3		1303-1530	147	1,2	1	2005	0.41820	200	400	3,300	-
	3A		0317-0322									
			0333-0338									
			0424-0429	15	1,4	1	2006	0.00870	-	-	-	2.04
2	1-Stage 5	7-8-76			1,4	2	3010	0.05820	-	-	-	-
	4	to			1,4	2	3009	0.07140	-	-	-	-
	3	7-9-76			1,4	2	3008	0.07830	-	-	-	-
	2				1,4	2	3007	0.21990	-	-	-	-
	1				1,4	2	3006	0.52360	-	-	-	-
	Backup				1,4	1	2015	0.47040	-	-	-	-
	Total		1715-0722	847	-	-	-	1.42180	-	-	-	-
	1-Top		1627-0714	887	1,2	1	2009	4.09710	660	1,060	7,800	-
	1-Bottom		1627-0714	887	1,2	1	2010	3.06670	640	710	5,100	-
	2-North		1635-0725	890	1,2	1	2012	5.23480	520	1,730	19,000	-
	2-South		1640-0730	890	1,2	1	2011	5.22060	520	1,570	7,800	-
	3		1650-~ 1930	160	1,4	1	2013	0.15180	-	-	-	-
	3A		1700-0800	900	1,2	1	2014	0.20790	79	62	510	-
3	1-Top	7-9-76	0840-1222	222	1,2	1	2020	1.57840	700	550	4,600	-
	1-Bottom		0840-1222	222	1,2	1	2019	1.95200	640	570	5,500	-
	2-N. Stage 5				1,2	2	3015	0.04020	25	11	300	-
	4				1,2	2	3014	0.03370	22	12	170	-
	3				1,2	2	3013	0.02170	14	8	70	-
	2				1,2	2	3012	0.02270	14	6	60	-
	1				1,2	2	3011	0.02250	13	7	45	-
	Backup				1,2	1	2021	0.27550	154	69	1,400	-
	Total		1100-1515	255	-	-	-	0.41630	242	113	2,045	-

TABLE 4 (continued)

Sampling Data								Mass[d]				
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Mass (g)	Pb Weight (mg)	As Weight (μg)	Cd Weight (μg)	Particulate Density[e]
3	2-South	7-9-76	0730-1505	455	1,4	1	2016	1.51610	-	-	-	2.62
	3		0730-1545	495	1,2	1	2017	0.53050	260	390	2,100	-
	3A		9, 5-min intervals[f]	45	1,2	1	2018	0.02620	16	47	< 120	-
4	2-North	7-9-76	1535-0905	1,050	1,4	1	2025	5.62215	-	-	-	2.54
	2-South	to	1540-0905	1,045	1,2	1	2022	6.71175	1,210	2,010	9,400	-
	3-Stage 5	7-10-76	1547-0900	1,033	1,2	2	3021	0.04690	20	30	160	-
	4		1547-0900	1,033	1,2	2	3020	0.03925	18	27	130	-
	3		1547-0900	1,033	1,2	2	3019	0.02965	15	16	80	-
	2		1547-0900	1,033	1,2	2	3018	0.04855	27	19	100	-
	1		1547-0900	1,033	1,2	2	3017	0.09090	54	27	140	-
	Backup		1547-0900	1,033	1,4	1	2026	0.05295	33[g]	13[g]	-	-
	Total		1547-0900	1,033	-	-	-	0.30820	167	132	610	-
	3		1540-0900	1,044	1,2	1	2023	0.59540	290	350	1,500	-
	3A		1555-0900	1,025	1,2	1	2024	0.23785	83	130	400	-
5	1-Top	7-12-76	0745-1330	345	1,4	1	2031	0.12850	-	-	-	3.13
	1-Bottom		0745-1330	345	1,3	1	2032	0.16270	-	-	-	-
	2-North		0830-1415	345	1,3	1	2027	1.79595	-	-	-	-
	2-South		0830-1415	345	1,2	1	2028	3.10760	460	840	7,100	-
	3		0900-1500	360	1,3	1	2033	1.21950	-	-	-	-
	3A		0845-1500	375	1,2	1	2030	0.16025	62	370	1,300	-
6	4	7-12-76	1600-0915	1,035	1,4	1	2035	14.55745[h]	-	-	-	3.25
	5	to 7-13-76	1600-0915	1,035	1,2	1	2036	0.37015	180	85	780	-
7	4	7-13-76	1300-1545	165	1,2	1	2037	1.16215	480	430	2,100	-
	5		1300-1545	165	1,4	1	2038	0.07040	-	-	-	3.67
8	4-Stage 5	7-13-76	1600-0730	930	1,2	2	3027	0.07375	40	30	120	-
	4	to 7-14-76	1600-0730	930	1,2	2	3028	0.07650	38	19	130	-
	3		1600-0730	930	1,2	2	3029	0.08125	45	28	120	-
	2		1600-0730	930	1,2	2	3030	0.17685	100	54	290	-
	1		1600-0730	930	1,2	2	3031	0.31530	170	85	440	-
	Backup		1600-0730	930	1,2	1	2045	1.21245	836	300	1,600	-
	Total		1600-0730	930	-	-	-	1.93610	1,229	516	2,700	-
	5		1600-0730	930	1,3	1	2042	0.14060	-	-	-	-
	6-North		1400-1400	1,440	1,4	1	2040	0.30670	-	-	-	1.20
	6-South		1400-1400	1,440	1,3	1	2039	0.99320	-	-	-	-
	6-Overpass		1400-1400	1,440	1,2	1	2041	1.67345	200	240	11,000	-
9	4	7-14-76	0725-1245	320	1,2	1	2044	0.59635	300	120	890	-
	5	7-14-76	0730-1245	315	1,2	1	2043	0.10295	52	25	290	-
10	4	7-14-76	1600-0720	920	1,2	1	2052	9.78630	2,800	2,060	15,000	-
	5-Stage 5	to	1300-1600	180	1,2	2	3032	0.00730	1.6	[i]	25	-
	4	7-15-76	1300-1600	180	1,2	2	3033	0.01085	2.2	[i]	30	-
	3		1300-1600	180	1,2	2	3034	0.00900	1.7	[i]	20	-
	2		1300-1600	180	1,2	2	3035	0.01785	2.7	[i]	30	-

TABLE 4 (continued)

Sampling Data								Mass[d]				
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Mass (g)	Pb Weight (mg)	As Weight (µg)	Cd Weight (µg)	Particulate Density[e]
10	5-Stage 1		1300-1600	180	1,2	2	3036	0.03520	5.0	[i]	50	-
	Backup		1300-1600	180	1,2	1	2046	0.07410	20	< 24	250	-
	Total		1300-1600	180	-	-	-	0.15430	33.2	-	405	-
	5		1600-0730	930	1,2	1	2053	0.17950	48	30	200	-
	6 North		1400-0800	1,080	1,2	1	2048	4.56845	170	280	460	-
	6 South		1400-0800	1,080	1,2	1	2049	0.12020	10	7.6	79	-
	6 Overpass		1400-0800	1,080	1,2	1	2050	0.46765	220	94	800	-
11	4	7-14-76	1230-1600	210	1,3	1	2047	0.36550	-	-	-	-
12	4A	7-15-76	0720-1300	340	1,4	1	2057	0.16015	-	-	-	-
	5A		0730-1300	330	1,4	1	2055	0.48420	-	-	-	-
	6 N. Stage 5		1245-1430	105	1,2	2	3037	0.00050	[j]	[j]	[j]	-
	4		1245-1430	105	1,2	2	3038	0.00060	[j]	[j]	[j]	-
	3		1245-1430	105	1,2	2	3039	0.00070	[j]	[j]	[j]	-
	2		1245-1430	105	1,2	2	3040	0.00150	[j]	[j]	[j]	-
	1		1245-1430	105	1,2	2	3041	0.00240	[j]	[j]	[j]	-
	Backup		1245-1430	105	1,2	1	2054	0.01135	[j]	[j]	[j]	-
	Total		1245-1430	105	-	-	-	0.01705	-	-	-	-
	6 North		0800-1245	285	1,2	1	2059	0.07670	10	6.1	31	-
	6 South		0800-1430	390	1,2	1	2060	0.05990	8.9	5.9	57	-
	6 Overpass		0800-1415	375	1,2	1	2056	0.22090	64	30	800	-
20	11	7-22-76	1530-0744	974	1,2	1	2061	6.10979	500	45,000	21,000	-
	12	to	1530-0754	994	1,2	1	2062	3.95770	710	100,000	30,000	-
	13	7-23-76	1550-0738	948	1,2	1	2063	12.37949	580	66,000	35,000	-
	14		1520-0740	980	1,2	1	2064	4.23709	280	28,000	14,000	-
	15		1530-0800	990	1,2	1	2065	3.33584	460	16,000	9,700	-
	16		1515-0730	995	1,2	1	2066	7.63312	440	34,000	17,000	-
21	11-Stage 5	7-23-76	0752-1510	438	1,3	2	3046	0.14165	-	-	-	-
	4		0752-1510	438	1,3	2	3045	0.15989	-	-	-	-
	3		0752-1510	438	1,3	2	3044	0.16274	-	-	-	-
	2		0752-1510	438	1,3	2	3043	0.38314	-	-	-	-
	1		0752-1510	438	1,3	2	3042	0.25195	-	-	-	-
	Backup		0752-1510	438	1,3	1	2069	2.10208	-	-	-	-
	Total		0752-1510	438	-	-	-	3.20145	-	-	-	-
	12		0807-1520	433	1,4	1	2070	2.79414	-	-	-	1.83
	13-Stage 5		0742-1540	478	1,4	2	3051	0.04672	-	-	-	-
	4		0742-1540	478	1,4	2	3050	0.05763	-	-	-	-
	3		0742-1540	478	1,4	2	3049	0.04963	-	-	-	-
	2		0742-1540	478	1,4	2	3048	0.07515	-	-	-	-
	1		0742-1540	478	1,4	2	3047	0.06705	-	-	-	-
	Backup		0742-1540	478	1,4	1	2071	0.62258	-	-	-	-
	Total		0742-1540	478	-	-	-	0.91876	-	-	-	-

TABLE 4 (continued)

Run No.a/	Locationb/	Sampling Date Date	Sampling Date Time	Sampling Period (min)	Samplesc/ Set	Samplesc/ Type	Filter No.	Total Mass (g)	Massd/ Pb Weight (mg)	Massd/ As Weight (μg)	Massd/ Cd Weight (μg)	Particulate Densitye/
21	14		0750-1526	456	1,4	1	2072	0.81295	-	-	-	-
	15		0800-1508	428	1,4	1	2073	2.07325	-	-	-	2.18
	16		0740-1519	459	1,4	1	2074	1.31916	-	-	-	1.46
22	11	7-23-76	1515-0740	985	1,3	1	2077	3.31530	-	-	-	-
	12	to	1530-0745	975	1,2	1	2078	4.53354	360	25,000	13,000	-
	13	7-24-76	1540-0750	970	1,2	1	2079	6.31566	520	27,000	18,000	-
	14A		1547-0735	948	1,2	1	2075	3.87745	330	14,000	8,400	-
	15		1514-0730	976	1,2	1	2076	4.77730	1,100	27,000	10,000	-
	16		1523-0732	969	1,2	1	2080	0.73253	140	3,200	2,000	-
23	21	7-26-76	1005-1445	280	1,4	1	2081	1.04440	-	-	-	-
	22		1220-1450	150	1,4	1	2086	0.13060	-	-	-	-
	23		1030-1457	267	1,4	1	2082	1.40452	-	-	-	1.54
	23A		1315-1505	110	1,4	1	2087	0.50516	-	-	-	1.08
	24-North	7-26-76	1035-1515	280	1,4	1	2083	0.99274	-	-	-	-
	24-South		1040-1520	280	1,4	1	2084	1.63199	-	-	-	-
24	23	7-26-76	1501-0750	1,009	1,2	1	2089	4.07450	330	1,900	770	-
	23A	to 7-27-76	1510-0800	1,010	1,2	1	2090	1.41017	35	1,600	520	-
25	21	7-27-76	0730-1425	415	1,2	1	2096	0.89180	81	3,000	460	-
	22		0735-1430	415	1,2	1	2097	0.47760	34	2,800	< 220	-
	23		0753-1045	172	1,2	1	2098	1.14703	150	3,700	370	-
	23A		0802-1100	178	1,3	1	2099	0.65322	-	-	-	-
	24-North		0820-1500	400	1,3	1	2100	2.55882	-	-	-	-
	24-South		0810-1510	420	1,3	1	2101	2.57388	560	12,000	13,000	-
26	23-Stage 5		1055-1445	410	1,4	2	3056	0.32889	-	-	-	-
	4		1055-1445	410	1,4	2	3055	0.25912	-	-	-	-
	3		1055-1445	410	1,4	2	3054	0.13789	-	-	-	-
	2		1055-1445	410	1,4	2	3053	0.13282	-	-	-	-
	1		1055-1445	410	1,4	2	3052	0.09780	-	-	-	-
	Backup		1055-1445	410	1,4	1	2091	0.50102	-	-	-	-
	Total		1055-1445	410	-	-	-	1.45754	-	-	-	-
	23A-Stage 5		1100-1450	230	1,2	2	3061	0.05525	1.4	59	30	-
	4		1100-1450	230	1,2	2	3060	0.05805	1.7	79	25	-
	3		1100-1450	230	1,2	2	3059	0.04895	1.7	79	30	-
	2		1100-1450	230	1,2	2	3058	0.06774	1.7	59	20	-
	1		1100-1450	230	1,2	2	3057	0.06724	1.7	79	20	-
	Backup		1100-1450	230	1,2	1	2092	0.43771	9.2	530	130	-
	Total		1100-1450	230	-	-	-	0.73494	17.4	885	255	-
27	17	7-27-76	1530-0930	1,080	1,2	1	2095	1.23887	280	82,000	4,500	-
	18	to	1530-0920	1,070	1,2	1	2102	1.45595	350	69,000	7,100	-
	23	7-28-76	1447-0725	998	1,2	1	2093	4.60965	210	27,000	1,100	-
	23A		1455-0700	1,005	1,2	1	2094	2.19038	15	780	320	-
28	17	7-28-76	0935-1505	330	1,4	1	2106	0.60779	-	-	-	3.27

TABLE 4 (continued)

Run No.[a]	Location[b]	Sampling Date		Sampling Period (min)	Samples[c]		Filter No.	Mass[d]				Particulate Density[e]
		Date	Time		Set	Type		Total Mass (g)	Pb Weight (mg)	As Weight (µg)	Cd Weight (µg)	
28	18		0925-1510	345	1,4	1	2107	0.53015	-	-	-	2.63
	19		0850-1530	400	1,4	1	2103	2.41961	-	-	-	1.92
	20		0900-1530	390	1,4	1	2104	1.15240	-	-	-	2.40
29	17-Stage 5	7-28-76	1515-0745	990	1,3	2	3066	0.34124	-	-	-	-
	4	to	1515-0745	990	1,3	2	3065	0.35029	-	-	-	-
	3	7-29-76	1515-0745	990	1,3	2	3064	0.19679	-	-	-	-
	2		1515-0745	990	1,3	2	3063	0.18714	-	-	-	-
	1		1515-0745	990	1,3	2	3062	0.10164	-	-	-	-
	Backup		1515-0745	990	1,3	1	2108	0.15783	-	-	-	-
	Total		1515-0745	990	-	-	-	1.33493	-	-	-	-
	18-Stage 5		1520-0740	980	1,4	2	3071	0.50762	-	-	-	-
	4		1520-0740	980	1,4	2	3070	0.64400	-	-	-	-
	3		1520-0740	980	1,4	2	3069	0.43403	-	-	-	-
	2		1520-0740	980	1,4	2	3068	0.33408	-	-	-	-
	1		1520-0740	980	1,4	2	3067	0.28484	-	-	-	-
	Backup		1520-0740	980	1,4	1	2109	0.90215	-	-	-	-
	Total		1520-0740	980	-	-	-	3.10672	-	-	-	-
	19		1530-0810	1,000	1,2	1	2110	5.69144	1,100	80,000	370,000	-
	20		1535-0815	1,000	1,2	1	2111	7.02538	340	77,000	440,000	-
30	17	7-29-76	0747-1035	168	1,2	1	2112	0.77244	180	63,000	3,600	-
	18		0745-1050	185	1,3	1	2113	1.46001	-	-	-	-
	19		0815-1510	415	1,2	1	2114	1.81513	270	23,000	110,000	-
	20		0817-1520	423	1,2	1	2115	2.33558	270	22,000	160,000	-
31	17-Stage 5	7-29-76	1040-1455	255	1,4	2	3006	0.15191	-	-	-	-
	4		1040-1455	255	1,4	2	3085	0.13893	-	-	-	-
	3		1040-1455	255	1,4	2	3084	0.07936	-	-	-	-
	2		1040-1455	255	1,4	2	3083	0.08398	-	-	-	-
	1		1040-1455	255	1,4	2	3082	0.09952	-	-	-	-
	Backup		1040-1455	255	1,4	1	2117	0.31688	-	-	-	-
	Total		1040-1455	255	-	-	-	0.87058	-	-	-	-
	18-Stage 5		1055-1500	245	1,3	2	3081	0.05415	-	-	-	-
	4		1055-1500	245	1,3	2	3080	0.06294	-	-	-	-
	3		1055-1500	245	1,3	2	3079	0.05670	-	-	-	-
	2		1055-1500	245	1,3	2	3078	0.06660	-	-	-	-
	1		1055-1500	245	1,3	2	3077	0.04366	-	-	-	-
	Backup		1055-1500	245	1,3	1	2118	0.14768	28	8,000	< 210	-
	Total		1055-1500	245	-	-	-	0.43173	-	-	-	-
32	17	7-29-76	1500-0725	985	1,2	1	2121	5.57925	720	470,000	11,000	-
	18	to	1505-0730	985	1,2	1	2122	5.56244	610	370,000	16,000	-
	19	7-30-76	1515-0740	985	1,2	1	2119	11.40561	680	180,000	650,000	-
	20		1520-0745	985	1,2	1	2120	6.33177	380	62,000	1,000,000	-

TABLE 4 (concluded)

		Sampling Date						Mass[d]				
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Mass (g)	Pb Weight (mg)	As Weight (µg)	Cd Weight (µg)	Particulate Density[e]
33	17	7-30-76	0730-1340	370	1,2	1	2123	1.30026	400	120,000	3,800	-
	18		0735-1340	365	1,2	1	2124	1.18534	360	60,000	5,600	-
	19-Stage 5		0740-1400	380	1,2	2	3101	0.17029	6.5	2,000	16,000	-
	4		0740-1400	380	1,2	2	3100	0.10984	8.6	1,600	14,000	-
	3		0740-1400	380	1,2	2	3099	0.05966	5.5	540	7,700	-
	2		0740-1400	380	1,2	2	3098	0.04641	4.1	260	2,300	-
	1		0740-1400	380	1,2	2	3097	0.03225	4.8	220	950	-
	Backup		0740-1400	380	1,2	1	2125	0.29553	14.0	6,200	30,000	-
	Total		0740-1400	380	-	-	-	0.71398	43.5	10,820	70,950	-
	20-Stage 5		0750-1355	365	1,4	2	3091	0.27062	-	-	-	-
	4		0750-1355	365	1,4	2	3090	0.18790	-	-	-	-
	3		0750-1355	365	1,4	2	3089	0.10651	-	-	-	-
	2		0750-1355	365	1,4	2	3088	0.07675	-	-	-	-
	1		0750-1355	365	1,4	2	3087	0.06564	-	-	-	-
	Backup		0750-1355	365	1,4	1	2126	0.58976	-	-	-	-
	Total		0750-1355	365	-	-	-	1.29718	-	-	-	-

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a/ Runs 1 through 12 were at Glover, Missouri. Runs 20 through 33 were at East Helena, Montana. There were no Runs 13 through 19.

b/ See Figures 1 and 2. Location 1 had three sampling points. Two (1-Top and 1-Bottom) were on the vertical-profile sampler, and one was a HiVol positioned on the ground at the same height as 1-Bottom.

c/ Sets 1 and 2 were samples analyzed by MRI; Set 3 was analyzed by Physical Electronic Industries in Minneapolis; and Set 4 was analyzed by Walter C. McCrone Associates, Inc., in Chicago. Type 1 are 8 in. x 10 in. glass-fiber filters used in HiVol samplers; Type 2 are 4 in. x 5 in. glass-fiber filters used in the sieve impactor, which in turn was used in HiVol samplers or MRI's vertical-profile sampling apparatus.

d/ No weights were obtained for sample sets 3 and 4.

e/ Density values were determined for only a limited number of samples--only for those shown in table.

f/ Test periods for Location 3 of Run 3 are 0800-0805, 0846-0851, 0935-0940, 1011-1016, 1100-1105, 1135-1140, 1339-1344, 1439-1444, 1530-1535.

g/ These values were estimated by using the percentage of Pb and As from the backup filters for other runs; i.e., 62% and 25%, respectively.

h/ Partially broken hood on ventilator accounted for heavy concentration of material on filter; ventilator directly below filter.

i/ Weight of blank within 10% of weight of As; therefore, As value not usable.

j/ Sample weight ≤ 2 mg; could not be analyzed.

TABLE 5

PARTICULATE CONCENTRATIONS: TOTAL PARTICULATE, LEAD, ARSENIC AND CADMIUM

Sampling Data								Concentrations[d] (µg/m^3)							
				Sampling	Samples[c]		Filter	Total Particulate Conc.		Pb Conc.		As Conc.		Cd Conc.	
Run No.[a]	Location[b]	Date	Time	Period (min)	Set	Type	No.	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]
1	1-Stage 5	7/8/76			1,3	2	3000	213	215	-	-	-	-	-	-
	4				1,3	2	3001	278	281	-	-	-	-	-	-
	3				1,3	2	3002	226	229	-	-	-	-	-	-
	2				1,3	2	3003	348	352	-	-	-	-	-	-
	1				1,3	2	3004	2,570	2,610	-	-	-	-	-	-
	Backup				1,3	1	2007	2,660	2,690	-	-	-	-	-	-
	Total		1250-1610	200	-	-	-	6,300	6,370	-	-	-	-	-	-
	1-Top		0827-0830 1247-1605	198 + 3	1,2	1	2003	2,060	2,090	927	939	0.47	0.48	4.34	4.40
	1-Bottom		0827-0830 1247-1605	198 + 3	1,4	1	2004	11,000	11,100	-	-	-	-	-	-
	2-North		1300-1632	212	1,2	1	2001	3,330	3,370	1,980	2,010	0.95	0.96	21.0	21.3
	2-South		1310-1640	210	1,2	1	2002	2,920	2,960	1,540	1,560	0.91	0.92	5.91	5.98
	3		1303-1530	147	1,2	1	2005	1,900	1,920	905	917	1.81	1.84	15.0	15.2
	3A		0317-0322 0333-0338 0424-0429	15	1,4	1	2006	394	399	-	-	-	-	-	-
2	1-Stage 5	7/8/76			1,4	2	3010	60.7	58.9	-	-	-	-	-	-
	4	to			1,4	2	3009	74.4	72.3	-	-	-	-	-	-
	3	7/9/76			1,4	2	3008	81.6	79.3	-	-	-	-	-	-
	2				1,4	2	3007	229	223	-	-	-	-	-	-
	1				1,4	2	3006	546	530	-	-	-	-	-	-
	Backup				1,4	1	2015	490	476	-	-	-	-	-	-
	Total		1715-0722	847	-	-	-	1,480	1,440	-	-	-	-	-	-
	1-Top		1627-0714	887	1,2	1	2009	4,380	4,270	705	687	1.13	1.10	8.34	8.12
	1-Bottom		1627-0714	887	1,2	1	2010	3,280	3,190	684	666	0.76	0.74	5.45	5.31
	2-North		1635-0725	890	1,2	1	2012	11,500	11,200	1,150	1,120	3.81	3.71	41.9	40.8
	2-South		1640-0730	890	1,2	1	2011	5,180	5,040	516	502	1.56	1.52	7.74	7.54
	3		1650-≈1930	160	1,4	1	2013	632	634	-	-	-	-	-	-
	3A		1700-0800	900	1,2	1	2014	163	158	62.0	60.2	0.049	0.047	0.40	0.39
3	1-Top	7/9/76	0840-1222	222	1,2	1	2020	6,740	6,770	2,990	3,000	2.35	2.36	19.6	19.7
	1-Bottom		0840-1222	222	1,2	1	2019	8,340	8,370	2,730	2,740	2.43	2.44	23.5	23.6
	2-N. Stage 5				1,2	2	3015	206	207	128	129	0.056	0.056	1.01	1.02
	4				1,2	2	3014	173	174	113	113	0.047	0.047	0.85	0.85
	3				1,2	2	3013	111	112	71.8	72.2	0.030	0.030	0.55	0.55
	2				1,2	2	3012	116	117	71.8	72.2	0.032	0.032	0.57	0.58
	1				1,2	2	3011	115	116	66.7	67.0	0.031	0.031	0.57	0.57
	Backup				1,2	1	2021	1,410	1,420	790	794	0.38	0.38	6.94	6.98
	Total		1100-1515	225	-	-	-	2,140	2,150	1,240	1,250	0.58	0.58	10.5	10.6

TABLE 5 (Continued)

Sampling Data								Concentrations[d] (μg/m^3)							
					Samples[c]			Total Particulate Conc.		Pb Conc.		As Conc.		Cd Conc.	
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Set	Type	Filter No.	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]
3	2-South	7/9/76	0730-1505	455	1,4	1	2016	3,100	3,090	-	-	-	-	-	-
	3		0730-1545	495	1,2	1	2017	714	715	350	351	0.52	0.53	2.83	2.83
	3A		9, 5-min intervals	45	1,2	1	2018	411	412	252	252	0.74	0.74	-	-
4	2-North	7/9/76	1535-0905	1,050	1,4	1	2025	17,200	16,700	-	-	-	-	-	-
	2-South	to	1540-0905	1,045	1,2	1	2022	5,970	5,810	1,080	1,050	1.79	1.74	8.36	8.14
	3-Stage 5	7/10/76	1547-0900	1,033	1,2	2	3021	40.0	39.0	17.1	16.6	0.026	0.025	0.14	0.13
	4		1547-0900	1,033	1,2	2	3020	33.6	32.7	15.4	15.0	0.023	0.022	0.11	0.11
	3		1547-0900	1,033	1,2	2	3019	25.3	24.7	12.8	12.5	0.014	0.013	0.07	0.07
	2		1547-0900	1,033	1,2	2	3018	41.5	40.4	23.1	22.5	0.016	0.016	0.08	0.08
	1		1547-0900	1,033	1,2	2	3017	77.7	75.7	46.2	45.0	0.023	0.022	0.12	0.12
	Backup		1547-0900	1,033	1,4	1	2026	45.2[f]	44.1[f]	28.2[f]	27.5[f]	0.011[f]	0.011[f]	-	-
	Total		1547-0900	1,033	-	-	-	263	257	143	139	0.11	0.11	0.52	0.51
	3		1540-0900	1,044	1,2	1	2023	381	377	186	184	0.22	0.22	0.96	0.95
	3A		1555-0900	1,025	1,2	1	2024	154	153	54.0	53.3	0.085	0.084	0.26	0.26
5	1-Top	7/12/76	0745-1330	345	1,4	1	2031	353	356	-	-	-	-	-	-
	1-Bottom		0745-1330	345	1,3	1	2032	447	451	-	-	-	-	-	-
	2-North		830-1415	345	1,3	1	2027	14,100	14,300	-	-	-	-	-	-
	2-South		830-1415	345	1,2	1	2028	8,160	8,230	1,210	1,220	2.20	2.23	18.6	18.8
	3		900-1500	360	1,3	1	2033	2,230	2,260	-	-	-	-	-	-
	3A		845-1500	375	1,2	1	2030	302	306	117	118	0.70	0.71	2.45	2.48
6	4	7/12/76	1600-0915	1,035	1,4	1	2035	9,930[g]	9,770[g]	-	-	-	-	-	-
	5	to 7/13/76	1600-0915	1,035	1,2	1	2036	218	214	106	104	0.050	0.049	0.46	0.45
7	4	7/13/76	1300-1545	165	1,2	1	2037	4,360	4,450	1,800	1,840	1.62	1.65	7.88	8.04
	5		1300-1545	165	1,4	1	2038	264	270	-	-	-	-	-	-
8	4-Stage 5	7/13/76	1600-0730	930	1,2	2	3027	80.0	79.1	43.4	42.9	0.033	0.032	0.13	0.13
	4	to 7/14/76	1600-0730	930	1,2	2	3028	83.0	82.1	41.2	40.7	0.021	0.020	0.14	0.14
	3		1600-0730	930	1,2	2	3029	88.2	87.2	48.8	48.3	0.030	0.030	0.13	0.13
	2		1600-0730	930	1,2	2	3030	192	190	108	107	0.059	0.058	0.31	0.31
	1		1600-0730	930	1,2	2	3031	342	338	184	182	0.092	0.091	0.48	0.47
	Backup		1600-0730	930	1,2	1	2045	1,320	1,300	907	897	0.33	0.32	1.74	1.72
	Total		1600-0730	930	-	-	-	2,100	2,080	1,330	1,320	0.56	0.55	2.93	2.90
	5		1600-0730	930	1,3	1	2042	92.0	91.0	-	-	-	-	-	-
	6-North		1400-1400	1,440	1,4	1	2040	139	139	-	-	-	-	-	-
	6-South		1400-1400	1,440	1,3	1	2039	252	252	-	-	-	-	-	-
	6-Overpass		1400-1400	1,440	1,2	1	2041	855	854	102	102	0.12	0.12	5.62	5.61

TABLE 5 (Continued)

Sampling Data								Concentrations d/ (µg/m³)							
								Total Particulate Conc.		Pb Conc.		As Conc.		Cd Conc.	
Run No. a/	Location b/	Date	Time	Sampling Period (min)	Samples c/ Set	Type	Filter No.	Act. Cond.	Std. Cond. e/	Act. Cond.	Std. Cond. e/	Act. Cond.	Std. Cond. e/	Act. Cond.	Std. Cond. e/
9	4	7/14/76	0725-1245	320	1,2	1	2044	1,150	1,160	581	586	0.23	0.23	1.72	1.74
	5	7/14/76	1730-1245	315	1,2	1	2043	196	197	98.8	100	0.048	0.048	0.55	0.56
10	4	7/14/76	1600-0720	920	1,2	1	2052	7,220	7,120	2,070	2,040	1.52	1.50	11.1	10.9
	5-Stage 5	to 7/15/76	1300-1600	180	1,2	2	3032	35.8	36.6	7.84	8.04	-	-	0.094	0.096
	4		1300-1600	180	1,2	2	3033	53.2	54.4	10.8	11.0	-	-	0.14	0.14
	3		1300-1600	180	1,2	2	3034	44.1	45.1	8.33	8.54	-	-	0.12	0.12
	2		1300-1600	180	1,2	2	3035	87.6	89.5	13.2	13.6	-	-	0.23	0.23
	1		1300-1600	180	1,2	2	3036	173	177	24.5	25.1	-	-	0.45	0.46
	Backup		1300-1600	180	1,2	1	2046	363	372	98.0	100	-	-	0.96	0.97
	Total		1300-1600	180	-	-	-	757	774	163	166	-	-	1.99	2.03
	5		1600-0730	930	1,2	1	2053	116	114	30.9	30.8	0.019	0.019	0.13	0.13
	6-North		1400-0800	1,080	1,2	1	2048	3,110	3,080	115	114	0.19	0.19	0.31	0.31
	6-South		1400-0800	1,080	1,2	1	2049	80.2	79.3	6.67	6.60	0.005	0.005	0.053	0.052
	6-Overpass		1400-0800	1,080	1,2	1	2050	300	296	141	139	0.060	0.060	0.51	0.51
11	4	7/14/76	1230-1600	210	1,3	1	2047	1,080	1,100	-	-	-	-	-	-
12	4A	7/15/76	0720-1300	340	1,4	1	2057	273	270	-	-	-	-	-	-
	5A		0730-1300	330	1,4	1	2055	893	885	-	-	-	-	-	-
	6N-Stage 5		1245-1430	105	1,2	2	3037	4.80	4.76	h/	h/	h/	h/	h/	h/
	4		1245-1430	105	1,2	2	3038	5.77	5.71	h/	h/	h/	h/	h/	h/
	3		1245-1430	105	1,2	2	3039	6.73	6.67	h/	h/	h/	h/	h/	h/
	2		1245-1430	105	1,2	2	3040	14.4	14.3	h/	h/	h/	h/	h/	h/
	1		1245-1430	105	1,2	2	3041	23.1	22.9	h/	h/	h/	h/	h/	h/
	Backup		1245-1430	105	1,2	1	2054	109	108	h/	h/	h/	h/	h/	h/
	Total		1245-1430	105	-	-	-	164	162	h/	h/	h/	h/	h/	h/
	6-North		0800-1245	285	1,2	1	2059	176	175	23.0	22.8	0.014	0.014	0.071	0.071
	6-South		0800-1430	390	1,2	1	2060	113	112	16.8	16.7	0.011	0.011	0.11	0.11
	6-Overpass		0800-1415	375	1,2	1	2056	408	405	118	117	0.055	0.055	1.48	1.47

TABLE 5 (Continued)

Sampling Data								Concentrations[d] (μg/m³)							
								Total Particulate Conc.		Pb Conc.		As Conc.		Cd Conc.	
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]
20	11	7/22/76	1530-0744	974	1,2	1	2061	6,710	6,620	549	541	49.4	48.7	23.1	22.7
	12	to	1530-0754	994	1,2	1	2062	4,260	4,120	764	753	108	106	32.3	31.8
	13	7/23/76	1550-0738	948	1,2	1	2063	15,900	15,700	745	734	83.5	82.3	45.0	44.3
	14		1520-0740	980	1,2	1	2064	3,390	3,340	224	221	22.4	22.1	11.2	11.0
	15		1530-0800	990	1,2	1	2065	2,640	2,610	365	360	12.7	12.5	7.69	7.58
	16		1515-0730	995	1,2	1	2066	7,320	7,220	422	416	32.6	32.1	16.3	16.1
21	11-Stage 5	7/23/76	0752-1510	438	1,3	2	3046	476	474	-	-	-	-	-	-
	4		0752-1510	438	1,3	2	3045	537	534	-	-	-	-	-	-
	3		0752-1510	438	1,3	2	3044	547	544	-	-	-	-	-	-
	2		0752-1510	438	1,3	2	3043	1,290	1,280	-	-	-	-	-	-
	1		0752-1510	438	1,3	2	3042	846	842	-	-	-	-	-	-
	Backup		0752-1510	438	1,3	1	2069	7,060	7,030	-	-	-	-	-	-
	Total		0752-1510	438	-	-	-	10,800	10,700	-	-	-	-	-	-
	12		0807-1520	433	1,4	1	2070	5,180	5,150	-	-	-	-	-	-
	13-Stage 5		0742-1540	478	1,4	2	3051	88.5	88.3	-	-	-	-	-	-
	4		0742-1540	478	1,4	2	3050	109	109	-	-	-	-	-	-
	3		0742-1540	478	1,4	2	3049	94.0	93.8	-	-	-	-	-	-
	2		0742-1540	478	1,4	2	3048	142	142	-	-	-	-	-	-
	1		0742-1540	478	1,4	2	3047	127	127	-	-	-	-	-	-
	Backup		0742-1540	478	1,4	1	2071	1,180	1,180	-	-	-	-	-	-
	Total		0742-1540	478	-	-	-	1,740	1,740	-	-	-	-	-	-
	14		0750-1526	456	1,4	1	2072	1,100	1,100	-	-	-	-	-	-
	15		0800-1508	428	1,4	1	2073	3,110	3,090	-	-	-	-	-	-
	16		0740-1519	459	1,4	1	2074	2,740	2,730	-	-	-	-	-	-
22	11	7/23/76	1515-0740	985	1,3	1	2077	3,130	3,130	296	296	20.6	20.6	10.7	10.7
	12	to	1530-0745	975	1,2	1	2078	3,730	3,730	498	498	25.9	25.8	17.2	17.2
	13	7/24/76	1540-0750	970	1,2	1	2079	6,050	6,050	256	256	10.9	10.9	6.52	6.52
	14A		1547-0735	948	1,2	1	2075	3,010	3,010	905	904	22.2	22.2	8.22	8.22
	15		1514-0730	976	1,2	1	2076	3,930	3,930	131	131	2.99	2.99	1.87	1.87
	16		1523-0732	969	1,2	1	2080	684	684	-	-	-	-	-	-
23	21	7/26/76	1005-1445	280	1,4	1	2081	2,120	2,140	-	-	-	-	-	-
	22		1220-1450	150	1,4	1	2086	559	569	-	-	-	-	-	-
	23		1030-1457	267	1,4	1	2082	3,950	3,980	-	-	-	-	-	-
	23A		1315-1505	110	1,4	1	2087	3,820	3,890						

TABLE 5 (Continued)

Sampling Data								Concentrations[d] (µg/m^3)							
				Sampling Period	Samples[c]		Filter	Total Particulate Conc.		Pb Conc.		As Conc.		Cd Conc.	
Run No.[a]	Location[b]	Date	Time	(min)	Set	Type	No.	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]
23	24-North	7/26/76	1035-1515	280	1,4	1	2083	2,360	2,380	-	-	-	-	-	-
	24-South		1040-1520	280	1,4	1	2084	3,610	3,640	-	-	-	-	-	-
24	23	7/26/76	1501-0750	1,009	1,2	1	2089	3,320	3,320	269	269	1.55	1.55	0.63	0.63
	23A	to 7/27/76	1510-0800	1,010	1,2	1	2090	1,230	1,230	30.6	30.6	1.40	1.40	0.46	0.46
25	21	7/27/76	0730-1425	415	1,2	1	2096	1,430	1,420	130	129	4.82	4.77	0.74	0.73
	22		0735-1430	415	1,2	1	2097	713	706	50.8	50.3	4.18	4.14	-	-
	23		0753-1045	172	1,2	1	2098	5,740	5,690	751	744	18.5	18.4	1.85	1.84
	23A		0802-1100	178	1,3	1	2099	3,320	3,280	-	-	-	-		
	24-North		0820-1500	400	1,3	1	2100	4,910	4,870	-	-	-	-		
	24-South		0810-1510	420	1,3	1	2101	4,010	3,980	872	865	18.7	18.5	20.2	20.1
26	23-Stage 5		1055-1445	410	1,4	2	3056	726	723	-	-	-	-	-	-
	4		1055-1445	410	1,4	2	3055	572	569	-	-	-	-	-	-
	3		1055-1445	410	1,4	2	3054	304	303	-	-	-	-	-	-
	2		1055-1445	410	1,4	2	3053	293	292	-	-	-	-	-	-
	1		1055-1445	410	1,4	2	3052	216	215	-	-	-	-	-	-
	Backup		1055-1445	410	1,4	1	2091	1,110	1,100	-	-	-	-	-	-
	Total		1055-1445	410	-	-	-	3,220	3,200	-	-	-	-	-	-
	23A-Stage 5		1100-1450	230	1,2	2	3061	229	228	5.81	5.81	0.24	0.24	0.12	0.12
	4		1100-1450	230	1,2	2	3060	241	240	7.05	7.05	0.33	0.33	0.10	0.10
	3		1100-1450	230	1,2	2	3059	203	202	7.05	7.05	0.33	0.33	0.12	0.12
	2		1100-1450	230	1,2	2	3058	281	280	7.05	7.05	0.24	0.24	0.083	0.083
	1		1100-1450	230	1,2	2	3057	279	278	7.05	7.05	0.33	0.33	0.083	0.083
	Backup		1100-1450	230	1,2	1	2097	1,820	1,809	38.2	37.8	0.66	0.65	0.54	0.53
	Total		1100-1450	230	-	-	-	3,050	3,030	72.2	71.8	3.65	3.64	1.06	1.05
27	17	7/27/76	1530-0930	1,080	1,2	1	2095	1,010	988	229	223	65.4	63.8		
	18	to	1530-0920	1,070	1,2	1	2102	1,200	1,170	289	282	56.1	54.7		
	23	7/28/76	1447-0725	998	1,2	1	2093	3,710	3,620	169	165	21.7	21.2		
	23A		1455-0700	1,005	1,2	1	2094	1,790	1,750	12.3	12.0	0.64	0.63		
28	17	7/28/76	0935-1505	330	1,4	1	2106	1,550	1,540	-	-	-	-	-	-
	18		0925-1510	345	1,4	1	2107	1,230	1,230	-	-	-	-	-	-
	19		0850-1530	400	1,4	1	2103	5,210	5,170	-	-	-	-	-	-
	20		0900-1530	390	1,4	1	2104	2,750	2,730	-	-	-	-	-	-

TABLE 5 (Continued)

Sampling Data								Concentrations[d] (μg/m^3)							
								Total Particulate Conc.		Pb Conc.		As Conc.		Cd. Conc.	
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]
29	17-Stage 5	7/28/76	1515-0745	990	1,3	2	3066	312	307	-	-	-	-	-	-
	4	to	1515-0745	990	1,3	2	3065	320	316	-	-	-	-	-	-
	3	7/29/76	1515-0745	990	1,3	2	3064	180	177	-	-	-	-	-	-
	2		1515-0745	990	1,3	2	3063	171	169	-	-	-	-	-	-
	1		1515-0745	990	1,3	2	3062	93	91.6	-	-	-	-	-	-
	Backup		1515-0745	990	1,3	1	2108	144	142	-	-	-	-	-	-
	Total		1515-0745	990	-	-	-	1,220	1,200	-	-	-	-	-	-
	18-Stage 5		1520-0740	980	1,4	2	3071	523	515	-	-	-	-	-	-
	4		1520-0740	980	1,4	2	3070	663	653	-	-	-	-	-	-
	3		1520-0740	980	1,4	2	3069	447	440	-	-	-	-	-	-
	2		1520-0740	980	1,4	2	3068	344	339	-	-	-	-	-	-
	1		1520-0740	980	1,4	2	3067	293	289	-	-	-	-	-	-
	Backup		1520-0740	980	1,4	1	2109	929	915	-	-	-	-	-	-
	Total		1520-0740	980	-	-	-	3,200	3,150	-	-	-	-		
	19		1530-0810	1,000	1,2	1	2110	7,440	7,320	1,440	1,420	105	103		
	20		1535-0815	1,000	1,2	1	2111	15,500	15,300	750	738	170	167		
30	17	7/29/76	0747-1035	168	1,2	1	2112	3,610	3,500	840	816	294	286		
	18		0745-1050	185	1,3	1	2113	6,330	6,150	-	-	-	-	-	-
	19		0815-1510	415	1,2	1	2114	4,410	4,280	656	636	55.9	54.2	267	259
	20		0817-1520	423	1,2	1	2115	6,090	5,900	704	682	57.4	55.6	417	404
31	17-Stage 5	7/29/76	1040-1455	255	1,4	2	3086	584	586	-	-	-	-	-	-
	4		1040-1455	255	1,4	2	3085	534	536	-	-	-	-	-	-
	3		1040-1455	255	1,4	2	3084	305	306	-	-	-	-	-	-
	2		1040-1455	255	1,4	2	3083	323	324	-	-	-	-	-	-
	1		1040-1455	255	1,4	2	3082	383	384	-	-	-	-	-	-
	Backup		1040-1455	255	1,4	1	2117	1,220	1,220	-	-	-	-	-	-
	Total		1040-1455	255	-	-	-	3,350	3,360	-	-	-	-	-	-
	18-Stage 5		1055-1500	245	1,3	2	3081	230	230	-	-	-	-	-	-
	4		1055-1500	245	1,3	2	3080	267	267	-	-	-	-	-	-
	3		1055-1500	245	1,3	2	3079	240	241	-	-	-	-	-	-
	2		1055-1500	245	1,3	2	3078	282	283	-	-	-	-	-	-
	1		1055-1500	245	1,3	2	3077	185	186	-	-	-	-	-	-
	Backup		1055-1500	245	1,3	1	2118	626	628	-	-	-	-	-	-
	Total		1055-1500	245	-	-	-	1,830	1,830	-	-	-	-	-	-

TABLE 5 (Concluded)

Sampling Data								Concentrations[d] (μg/m³)							
				Sampling	Samples[c]		Filter	Total Particulate Conc.		Pb Conc.		As. Conc.		Cd. Conc.	
Run No.[a]	Location[b]	Date	Time	Period (min)	Set	Type	No.	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]	Act. Cond.	Std. Cond.[e]
32	17	7/29/76	1500-0725	985	1,2	1	2121	7,140	7,070	922	912	602	596	14.1	13.9
	18	to	1505-0730	985	1,2	1	2122	10,500	10,400	1,150	1,140	698	691	30.2	29.9
	19	7/30/76	1515-0740	985	1,2	1	2119	18,600	18,400	1,110	1,100	293	290	1,060	1,050
	20		1520-0745	985	1,2	1	2120	10,800	10,700	649	642	106	105	1,710	1,690
33	17	7/30/76	0730-1340	370	1,2	1	2123	3,350	3,260	1,030	1,000	310	301	9.80	9.53
	18		0735-1340	365	1,2	1	2124	3,580	3,490	1,090	1,060	181	176	16.9	16.5
	19-Stage 5		0740-1400	380	1,2	2	3101	386	375	14.7	14.3	4.54	4.40	36.3	35.2
	4		0740-1400	380	1,2	2	3100	249	242	19.5	18.9	3.63	3.52	31.7	30.8
	3		0740-1400	380	1,2	2	3099	135	132	12.5	12.1	1.22	1.19	17.5	17.0
	2		0740-1400	380	1,2	2	3098	105	102	9.30	9.03	0.59	0.57	5.22	5.07
	1		0740-1400	380	1,2	2	3097	73.1	71.1	10.9	10.6	0.50	0.48	2.15	2.09
	Backup		0740-1400	380	1,2	1	2125	670	652	31.7	30.8	14.0	13.6	68.0	66.1
	Total		0740-1400	380	-	-	-	1,620	1,570	98.6	95.9	24.5	23.8	161	156
	20-Stage 5		0750-1355	365	1,4	2	3091	770	749	-	-	-	-	-	-
	4		0750-1355	365	1,4	2	3090	535	520	-	-	-	-	-	-
	3		0750-1355	365	1,4	2	3089	303	295	-	-	-	-	-	-
	2		0750-1355	365	1,4	2	3088	218	212	-	-	-	-	-	-
	1		0750-1355	365	1,4	2	3087	187	182	-	-	-	-	-	-
	Backup		0750-1355	365	1,4	1	2126	1,680	1,630	-	-	-	-	-	-
	Total		0750-1355	365	-	-	-	3,690	3,590	-	-	-	-	-	-

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[a] Runs 1 through 12 were at Glover, Missouri; Runs 20 through 33 were at East Helena, Montana. There were no Runs 13 through 19.

[b] See Figures 1 and 2. Location 1 had three sampling points. Two (1-Top and 1-Bottom) were on the vertical-profile sampler, and one was a HiVol positioned on the ground at the same height as 1-Bottom. Locations 4A, 5A, 6, 6N, 6S, 23A, 24N, and 24S provided only ambient-air background concentrations.

[c] Sets 1 and 2 were samples analyzed by MRI; Set 3 was analyzed by Physical Electronic Industries in Minneapolis; and Set 4 was analyzed by Walter C. McCrone Associates, Inc., in Chicago. Type 1 are 8 in. by 10 in. glass-fiber filters used in HiVol samplers. Type 2 are 4 in. x 5 in. glass-fiber filters used in the Sierra 5-stage impactor which in turn was used in HiVol samplers or in MRI's vertical-profile sampling apparatus.

[d] All concentrations are given in three significant figures, since climatic conditions, velometer measurements, and effective areas are no more accurate. Some Pb, As, and Cd concentrations are not given. This is because no weights were available from sample Sets 3 and 4.

[e] Standard conditions are 77°F and 29.92 in. Hg.

[f] These values were estimated by using the percentage of Pb and As from the back-up filters for other runs, i.e., 62% and 25%, respectively.

[g] Partially broken hood on ventilator accounted for heavy concentration of material on filter. Ventilator directly below filter.

[h] Since there was not sufficient sample weight to analyze, no concentrations could be analyzed.

TABLE 6

TOTAL PARTICULATE, PB, AS, AND CD EMISSION RATES

Sampling Data								Emission Rates[d] (mg/min)							
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Em. Rate Act. Cond. (mg/min)	Total Em. Rate Std. Cond.[e] (mg/min)	Pb Em. Rate Act. Cond. (mg/min)	Pb Em. Rate Std. Cond.[e] (mg/min)	As Em. Rate Act. Cond. (mg/min)	As Em. Rate Std. Cond.[e] (mg/min)	Cd Em. Rate Act. Cond. (mg/min)	Cd Em. Rate Std. Cond.[e] (mg/min)
1	1-Stage 5	7-8-76			1, 3	2	3000	232	235	-	-	-	-	-	-
	4				1, 3	2	3001	303	306	-	-	-	-	-	-
	3				1, 3	2	3002	246	249	-	-	-	-	-	-
	2				1, 3	2	3003	379	384	-	-	-	-	-	-
	1				1, 3	2	3004	2,810	2,840	-	-	-	-	-	-
	Backup				1, 3	1	2007	2,900	2,930	-	-	-	-	-	-
	Total		1250-1610	200	-	-	-	6,860	6,940	-	-	-	-	-	-
	1-Top		0827-0830	3	1, 2	1	2003	4,500	4,570	2,020	2,050	1.03	1.05	9.49	9.60
			1247-1605	198											
	1-Bottom		0827-0830	3	1, 4	1	2004	12,000	12,100	-	-	-	-	-	-
			1247-1605	198											
	2-North		1300-1632	212	1, 2	1	2001	11,100	11,300	6,630	6,720	3.19	3.21	70.4	71.2
	2-South		1310-1640	210	1, 2	1	2002	9,020	9,150	14,770	14,820	2.80	2.84	18.3	18.5
	3		1303-1530	147	1, 2	1	2005	-	-	-	-	-	-	-	-
	3A		0317-0322	15	1, 4	1	2006	-	-	-	-	-	-	-	-
			0333-0338												
			0424-0429												
2	1-Stage 5	7-8-76			1, 4	2	3010	358	348	-	-	-	-	-	-
	4	to			1, 4	2	3009	439	427	-	-	-	-	-	-
	3	7-9-76			1, 4	2	3008	482	468	-	-	-	-	-	-
	2				1, 4	2	3007	1,350	1,310	-	-	-	-	-	-
	1				1, 4	2	3006	3,220	3,130	-	-	-	-	-	-
	Backup				1, 4	1	2015	2,890	2,810	-	-	-	-	-	-
	Total		1715-0722	847	-	-	-	8,740	8,500	-	-	-	-	-	-
	1-Top		1627-0714	887	1, 2	1	2009	25,800	25,200	4,160	4,050	6.68	6.51	49.2	47.9
	1-Bottom		1627-0714	887	1, 2	1	2010	19,400	18,800	4,040	3,930	4.48	4.36	32.2	31.3
	2-North		1635-0725	890	1, 2	1	2012	38,400	37,500	3,830	3,750	12.8	12.4	140	136
	2-South		1640-0730	890	1, 2	1	2011	16,000	15,600	1,590	1,550	4.82	4.70	23.9	23.3
	3		1650-≈1930	160	1, 4	1	2013	8,920	8,950	-	-	-	-	-	-
	3A		1700-0800	900	1, 2	1	2014	5,640	5,480	2,140	2,080	1.68	1.64	13.8	13.4
3	1-Top	7-9-76	0840-1222	222	1, 2	1	2020	39,800	40,000	17,600	17,700	13.8	13.9	116	116
	1-Bottom		0840-1222	222	1, 2	1	2019	24,600	24,600	8,060	8,060	7.17	7.18	69.2	69.5
	2-N Stage 5				1, 2	2	3015	690	694	428	431	0.19	0.19	5.15	5.17
	4				1, 2	2	3014	518	582	377	379	0.20	0.21	2.92	2.93
	3				1, 2	2	3013	372	374	240	241	0.14	0.14	1.20	1.21
	2				1, 2	2	3012	389	392	240	241	0.10	0.10	1.03	1.03
	1				1, 2	2	3011	386	388	223	224	0.12	0.12	0.77	0.78
	Backup				1, 2	1	2021	4,730	4,750	2,640	2,660	1.18	1.19	24.0	24.1
	Total		1100-1515	255	-	-	-	7,150	7,190	4,150	4,180	1.94	1.94	35.1	35.3

TABLE 6 (continued)

Sampling Data								Emission Rates[d] (mg/min)							
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Em. Rate Act. Cond. (mg/min)	Total Em. Rate Std. Cond.[e] (mg/min)	Pb Em. Rate Act. Cond. (mg/min)	Pb Em. Rate Std. Cond.[e] (mg/min)	As Em. Rate Act. Cond. (mg/min)	As Em. Rate Std. Cond.[e] (mg/min)	Cd Em. Rate Act. Cond. (mg/min)	Cd Em. Rate Std. Cond.[e] (mg/min)
3	2-South	7-9-76	0730-1505	455	1, 4	1	2016	9,580	9,550	-	-	-	-	-	-
	3		0730-1545	495	1, 2	1	2017	10,900	10,900	5,340	5,350	8.02	8.09	43.2	43.2
	3A		Nine 5-min intervals	45	1, 2	1	2018	37,400	37,500	22,900	22,900	67.2	67.4	-	-
4	2-North	7-9-76	1535-0905	1,050	1, 4	1	2025	57,500	55,900	-	-	-	-	-	-
	2-South	to	1540-0905	1,045	1, 2	1	2022	18,400	18,000	3,320	3,240	5.52	5.38	25.8	25.2
	3-Stage 5	7-10-76	1547-0900	1,033	1, 2	2	3021	612	596	261	254	0.39	0.38	2.09	2.04
	4		1547-0900	1,033	1, 2	2	3020	512	499	235	229	0.35	0.34	1.69	1.65
	3		1547-0900	1,033	1, 2	2	3019	387	377	196	191	0.21	0.20	1.04	1.02
	2		1547-0900	1,033	1, 2	2	3018	634	617	352	343	0.25	0.24	1.30	1.27
	1		1547-0900	1,033	1, 2	2	3017	1,190[f]	1,160[f]	705[f]	687[f]	0.35[f]	0.34[f]	1.82[f]	1.78[f]
	Backup		1547-0900	1,033	1, 4	1	2026	691	673	431	420	0.17	0.16	-	-
	Total		1547-0900	1,033	-	-	-	4,020	3,920	2,180	2,120	1.72	1.68	7.96	7.76
	3		1540-0900	1,044	1, 2	1	2023	5,820	5,760	2,840	2,810	3.42	3.36	14.7	14.5
	3A		1555-0900	1,025	1, 2	1	2024	10,100	10,000	3,540	3,500	5.54	5.47	17.0	16.8
5	1-Top	7-12-76	0745-1330	345	1, 4	1	2031	8,490	8,570	-	-	-	-	-	-
	1-Bottom		0745-1330	345	1, 3	1	2032	5,360	5,410	-	-	-	-	-	-
	2-North		0830-1415	345	1, 3	1	2027	47,200	47,800	-	-	-	-	-	-
	2-South		0830-1415	345	1, 2	1	2028	25,200	25,400	3,740	3,770	6.81	6.89	57.5	58.1
	3		0900-1500	360	1, 3	1	2033	22,500	22,800	-	-	-	-	-	-
	3A		0845-1500	375	1, 2	1	2030	24,800	25,100	9,580	9,670	57.2	58.2	201	203
6	4	7-12-76 to	1600-0915	1,035	1, 4	1	2035	1,820[g]	1,800[g]	-	-	-	-	-	-
	5	7-13-76	1600-0915	1,035	1, 2	1	2036	1,210	1,190	589	579	0.28	0.27	2.55	2.51
7	4	7-13-76	1300-1545	165	1, 2	1	2037	801	819	331	339	0.30	0.30	1.45	1.48
	5		1300-1545	165	1, 4	1	2038	2,760	2,820	-	-	-	-	-	-
8	4-Stage 5	7-13-76 to	1600-0730	930	1, 2	2	3027	14.7	14.5	7.99	7.90	0.006	0.006	0.024	0.024
	4	7-14-76	1600-0730	930	1, 2	2	3028	15.2	15.1	7.59	7.51	0.004	0.004	0.026	0.026
	3		1600-0730	930	1, 2	2	3029	16.2	16.0	8.99	8.89	0.006	0.006	0.024	0.024
	2		1600-0730	930	1, 2	2	3030	35.2	34.8	20.0	19.8	0.011	0.011	0.058	0.057
	1		1600-0730	930	1, 2	2	3031	62.8	62.3	34.0	33.6	0.017	0.017	0.088	0.087
	Backup		1600-0730	930	1, 2	1	2045	241	239	167	165	0.060	0.059	0.319	0.316
	Total		1600-0730	930	-	-	-	385	383	245	243	0.10	0.10	0.539	0.533
	5		1600-0730	930	1, 3	1	2042	713	706	-	-	-	-	-	-
	6-North		1400-1400	1,440	1, 4	1	2040	-	-	-	-	-	-	-	-
	6-South		1400-1400	1,440	1, 3	1	2039	-	-	-	-	-	-	-	-
	6-Overpass		1400-1400	1,440	1, 2	1	2041								

TABLE 6 (continued)

Sampling Data								Emission Rates[d] (mg/min)							
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Em. Rate Act. Cond. (mg/min)	Total Em. Rate Std. Cond.[e] (mg/min)	Pb Em. Rate Act. Cond. (mg/min)	Pb Em. Rate Std. Cond.[e] (mg/min)	As Em. Rate Act. Cond. (mg/min)	As Em. Rate Std. Cond.[e] (mg/min)	Cd Em. Rate Act. Cond. (mg/min)	Cd Em. Rate Std. Cond.[e] (mg/min)
9	4	7-14-76	0725-1245	320	1, 2	1	2044	212	214	107	108	0.043	0.043	0.32	0.32
	5	7-14-76	0730-1245	315	1, 2	1	2043	2,370	2,390	1,200	1,210	0.58	0.58	6.68	6.74
10	4	7-14-76	1600-0720	920	1, 2	1	2052	1,330	1,310	382	375	0.28	0.27	2.04	2.00
	5-Stage 5	to	1300-1600	180	1, 2	2	3032	615	629	134	135	-	-	2.11	2.16
	4	7-15-76	1300-1600	180	1, 2	2	3033	915	935	185	190	-	-	2.53	2.59
	3		1300-1600	180	1, 2	2	3034	759	776	143	147	-	-	1.68	1.73
	2		1300-1600	180	1, 2	2	3035	1,500	1,540	227	233	-	-	2.53	2.59
	1		1300-1600	180	1, 2	2	3036	2,970	3,030	421	431	-	-	4.21	4.32
	Backup		1300-1600	180	1, 2	1	2046	6,250	6,390	1,680	1,730	-	-	21.1	21.6
	Total		1300-1600	180	-	-	-	13,000	13,300	2,800	2,860	-	-	34.1	34.9
	5		1600-0730	930	1, 2	1	2053	642	633	172	171	0.11	0.11	0.72	0.71
	6-North		1400-0800	1,080	1, 2	1	2048	-	-	-	-	-	-	-	-
	6-South		1400-0800	1,080	1, 2	1	2049	-	-	-	-	-	-	-	-
	6-Overpass		1400-0800	1,080	1, 2	1	2050	-	-	-	-	-	-	-	-
11	4	7-14-76	1230-1600	210	1, 3	1	2047	198	202	-	-	-	-	-	-
12	4A	7-15-76	0720-1300	340	1, 4	1	2057	-	-	-	-	-	-	-	-
	5A		0730-1300	330	1, 4	1	2055	-	-	-	-	-	-	-	-
	6 N-Stage 5		1245-1430	105	1, 2	2	3037	-	-	-	-	-	-	-	-
	4		1245-1430	105	1, 2	2	3038	-	-	-	-	-	-	-	-
	3		1245-1430	105	1, 2	2	3039	-	-	-	-	-	-	-	-
	2		1245-1430	105	1, 2	2	3040	-	-	-	-	-	-	-	-
	1		1245-1430	105	1, 2	2	3041	-	-	-	-	-	-	-	-
	Backup		1245-1430	105	1, 2	1	2054	-	-	-	-	-	-	-	-
	Total		1245-1430	105	-	-	-	-	-	-	-	-	-	-	-
	6-North		0800-1245	285	1, 2	1	2059	-	-	-	-	-	-	-	-
	6-South		0800-1430	390	1, 2	1	2060	-	-	-	-	-	-	-	-
	6-Overpass		0800-1415	375	1, 2	1	2056	-	-	-	-	-	-	-	-

TABLE 6 (continued)

Sampling Data								Emission Rates d/ (mg/min)							
Run No. a/	Location b/	Date	Time	Sampling Period (min)	Samples c/ Set	Samples c/ Type	Filter No.	Total Em. Rate Act. Cond. (mg/min)	Total Em. Rate Std. Cond. e/ (mg/min)	Pb Em. Rate Act. Cond. (mg/min)	Pb Em. Rate Std. Cond. e/ (mg/min)	As Em. Rate Act. Cond. (mg/min)	As Em. Rate Std. Cond. e/ (mg/min)	Cd Em. Rate Act. Cond. (mg/min)	Cd Em. Rate Std. Cond. e/ (mg/min)
20	11	7-22-76	1530-0744	974	1, 2	1	2061	12,500	12,400	1,030	1,010	92.4	91.0	43.1	42.5
	12	to	1530-0754	994	1, 2	1	2062	59.3	57.8	10.6	10.5	1.50	1.48	0.45	0.44
	13	7-23-76	1550-0738	948	1, 2	1	2063	14,100	13,900	661	652	74.1	73.1	39.9	39.3
	14		1520-0740	980	1, 2	1	2064	3,010	2,960	199	196	19.9	19.6	9.95	9.81
	15		1530-0800	990	1, 2	1	2065	988	975	136	134	4.74	4.67	2.87	2.83
	16		1515-0730	995	1, 2	1	2066	663	654	38.2	38.0	2.96	2.91	1.48	1.46
21	11-Stage 5	7-23-76	0752-1510	438	1, 3	2	3046	728	724	-	-	-	-	-	-
	4		0752-1510	438	1, 3	2	3045	821	817	-	-	-	-	-	-
	3		0752-1510	438	1, 3	2	3044	836	832	-	-	-	-	-	-
	2		0752-1510	438	1, 3	2	3043	1,970	1,960	-	-	-	-	-	-
	1		0752-1510	438	1, 3	2	3042	1,290	1,290	-	-	-	-	-	-
	Backup		0752-1510	438	1, 3	1	2069	10,800	10,700	-	-	-	-	-	-
	Total		0752-1510	438	-	-	-	16,400	16,400	-	-	-	-	-	-
	12		0807-1520	433	1, 4	1	2070	19.8	19.7	-	-	-	-	-	-
	13-Stage 5		0742-1540	478	1, 4	2	3051	77.1	76.9	-	-	-	-	-	-
	4		0742-1540	478	1, 4	2	3050	95.2	94.9	-	-	-	-	-	-
	3		0742-1540	478	1, 4	2	3049	81.9	81.7	-	-	-	-	-	-
	2		0742-1540	478	1, 4	2	3048	124	124	-	-	-	-	-	-
	1		0742-1540	478	1, 4	2	3047	111	110	-	-	-	-	-	-
	Backup		0742-1540	478	1, 4	1	2071	1,030	1,020	-	-	-	-	-	-
	Total		0742-1540	478	-	-	-	1,520	1,520	-	-	-	-	-	-
	14		0750-1526	456	1, 4	1	2072	357	355	-	-	-	-	-	-
	15		0800-1508	428	1, 4	1	2073	634	630	-	-	-	-	-	-
	16		0740-1519	459	1, 4	1	2074	1,240	1,240	-	-	-	-	-	-
22	11	7-23-76	1515-0740	985	1, 3	1	2077	2,130	2,130	-	-	-	-	-	-
	12	to	1530-0745	975	1, 2	1	2078	57.3	57.0	4.53	4.53	0.31	0.31	0.16	0.16
	13	7-24-76	1540-0750	970	1, 2	1	2079	5,860	5,860	482	482	25.0	25.0	16.7	16.7
	14A		1547-0735	948	1, 2	1	2075	315	315	26.8	26.8	1.14	1.14	0.68	0.68
	15		1514-0730	976	1, 2	1	2076	1,330	1,340	307	307	7.54	7.54	2.79	2.79
	16		1523-0732	969	1, 2	1	2080	372	372	71.2	71.2	1.63	1.62	1.02	1.02
23	21	7-26-76	1005-1445	280	1, 4	1	2081	3,410	3,430	-	-	-	-	-	-
	22		1220-1450	150	1, 4	1	2086	142	145	-	-	-	-	-	-
	23		1030-1457	267	1, 4	1	2082	11,400	11,400	-	-	-	-	-	-
	23A		1315-1505	110	1, 4	1	2087	-	-	-	-	-	-	-	-

TABLE 6 (continued)

Sampling Data								Emission Rates[d] (mg/min)							
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Total Em. Rate Act. Cond. (mg/min)	Total Em. Rate Std. Cond.[e] (mg/min)	Pb Em. Rate Act. Cond. (mg/min)	Pb Em. Rate Std. Cond.[e] (mg/min)	As Em. Rate Act. Cond. (mg/min)	As Em. Rate Std. Cond.[e] (mg/min)	Cd Em. Rate Act. Cond. (mg/min)	Cd Em. Rate Std. Cond.[e] (mg/min)
23	24-North	7-26-76	1035-1515	280	1, 4	1	2083	-	-	-	-	-	-	-	-
	24-South		1040-1520	280	1, 4	1	2084	-	-	-	-	-	-	-	-
24	23	7-26-76 to	1501-0750	1,009	1, 2	1	2089	10,000	10,100	814	815	4.69	4.70	1.90	1.90
	23A	7-27-76	1510-0800	1,010	1, 2	1	2090	-	-	-	-	-	-	-	-
25	21	7-27-76	0730-1425	415	1, 2	1	2096	5,070	5,030	464	457	17.2	16.9	2.64	2.61
	22		0735-1430	415	1, 2	1	2097	182	180	12.9	12.8	1.06	1.06	-	-
	23		0753-1045	172	1, 2	1	2098	13,900	13,800	1,820	1,800	44.9	44.6	4.49	4.45
	23A		0802-1100	178	1, 3	1	2099	-	-	-	-	-	-	-	-
	24-North		0820-1500	400	1, 3	1	2100	-	-	-	-	-	-	-	-
	24-South		0810-1510	420	1, 3	1	2101	-	-	-	-	-	-	-	-
26	23-Stage 5		1055-1445	410	1, 4	2	3056	1,980	1,970	-	-	-	-	-	-
	4		1055-1445	410	1, 4	2	3055	1,560	1,550	-	-	-	-	-	-
	3		1055-1445	410	1, 4	2	3054	830	826	-	-	-	-	-	-
	2		1055-1445	410	1, 4	2	3053	800	796	-	-	-	-	-	-
	1		1055-1445	410	1, 4	2	3052	589	586	-	-	-	-	-	-
	Backup		1055-1445	410	1, 4	1	2091	3,020	3,000	-	-	-	-	-	-
	Total		1055-1445	410	-	-	-	8,780	8,730	-	-	-	-	-	-
	23A-Stage 5		1100-1450	230	1, 2	2	3061	-	-	-	-	-	-	-	-
	4		1100-1450	230	1, 2	2	3060	-	-	-	-	-	-	-	-
	3		1100-1450	230	1, 2	2	3059	-	-	-	-	-	-	-	-
	2		1100-1450	230	1, 2	2	3058	-	-	-	-	-	-	-	-
	1		1100-1450	230	1, 2	2	3057	-	-	-	-	-	-	-	-
	Backup		1100-1450	230	1, 2	1	2097	-	-	-	-	-	-	-	-
	Total		1100-1450	230	-	-	-	-	-	-	-	-	-	-	-
27	17	7-27-76	1530-0930	1,080	1, 2	1	2095	16,800	16,400	3,790	3,690	1,080	1,080	-	-
	18	to	1530-0920	1,070	1, 2	1	2102	19,900	19,400	4,780	4,670	929	929	-	-
	23	7-28-76	1447-0725	998	1, 2	1	2093	8,990	8,770	409	400	52.6	51.4	-	-
	23A		1455-0700	1,005	1, 2	1	2094	-	-	-	-	-	-	-	-
28	17	7-28-76	0935-1505	330	1, 4	1	2106	21,300	21,200	-	-	-	-	-	-
	18		0925-1510	345	1, 4	1	2107	17,000	16,900	-	-	-	-	-	-
	19		0850-1530	400	1, 4	1	2103	7,080	7,030	-	-	-	-	-	-
	20		0900-1530	390	1, 4	1	2104	350	348	-	-	-	-	-	-

TABLE 6 (continued)

Sampling Data								Emission Rates d/ (mg/min)							
Run No. a/	Location b/	Date	Time	Sampling Period (min)	Samples c/ Set	Samples c/ Type	Filter No.	Total Em. Rate Act. Cond. (mg/min)	Total Em. Rate Std. Cond. e/ (mg/min)	Pb Em. Rate Act. Cond. (mg/min)	Pb Em. Rate Std. Cond. e/ (mg/min)	As Em. Rate Act. Cond. (mg/min)	As Em. Rate Std. Cond. e/ (mg/min)	Cd Em. Rate Act. Cond. (mg/min)	Cd Em. Rate Std. Cond. e/ (mg/min)
29	17-Stage 5	7-28-76	1515-0745	990	1, 3	2	3066	5,170	5,090	-	-	-	-	-	-
	4	to	1515-0745	990	1, 3	2	3065	5,310	5,230	-	-	-	-	-	-
	3	7-29-76	1515-0745	990	1, 3	2	3064	2,980	2,940	-	-	-	-	-	-
	2		1515-0745	990	1, 3	2	3063	2,840	2,790	-	-	-	-	-	-
	1		1515-0745	990	1, 3	2	3062	1,540	1,520	-	-	-	-	-	-
	Backup		1515-0745	990	1, 3	1	2108	2,390	2,360	-	-	-	-	-	-
	Total		1515-0745	990	-	-	-	20,200	19,900	-	-	-	-	-	-
	18-Stage 5		1520-0740	980	1, 4	2	3071	8,660	8,530	-	-	-	-	-	-
	4		1520-0740	980	1, 4	2	3070	11,000	10,800	-	-	-	-	-	-
	3		1520-0740	980	1, 4	2	3069	7,400	7,290	-	-	-	-	-	-
	2		1520-0740	980	1, 4	2	3068	5,700	5,610	-	-	-	-	-	-
	1		1520-0740	980	1, 4	2	3067	4,860	4,780	-	-	-	-	-	-
	Backup		1520-0740	980	1, 4	1	2109	15,400	15,200	-	-	-	-	-	-
	Total		1520-0740	980	-	-	-	53,000	52,200	-	-	-	-	-	-
	19		1530-0810	1,000	1, 2	1	2110	10,100	9,950	1,960	1,930	142	140	-	-
	20		1535-0815	1,000	1, 2	1	2111	1,980	1,950	95.6	94.0	21.7	21.3	-	-
30	17	7-29-76	0747-1035	168	1, 2	1	2112	25,700	25,000	6,000	5,820	2,100	2,040	-	-
	18		0745-1050	185	1, 3	1	2113	45,200	43,900	-	-	-	-	-	-
	19		0815-1510	415	1, 2	1	2114	6,000	5,820	892	864	76.0	73.7	364	352
	20		0817-1520	423	1, 2	1	2115	776	752	89.8	86.9	7.31	7.08	53.2	51.5
31	17-Stage 5	7-29-76	1040-1455	255	1, 4	2	3006	5,760	5,771	-	-	-	-	-	-
	4		1040-1455	255	1, 4	2	3085	5,270	5,280	-	-	-	-	-	-
	3		1040-1455	255	1, 4	2	3084	3,010	3,020	-	-	-	-	-	-
	2		1040-1455	255	1, 4	2	3083	3,180	3,190	-	-	-	-	-	-
	1		1040-1455	255	1, 4	2	3082	3,770	3,780	-	-	-	-	-	-
	Backup		1040-1455	255	1, 4	1	2117	12,000	12,000	-	-	-	-	-	-
	Total		1040-1455	255	-	-	-	33,000	33,100	-	-	-	-	-	-
	18-Stage 5		1055-1500	245	1, 3	2	3081	2,260	2,270	-	-	-	-	-	-
	4		1055-1500	245	1, 3	2	3080	2,630	2,640	-	-	-	-	-	-
	3		1055-1500	245	1, 3	2	3079	2,370	2,370	-	-	-	-	-	-
	2		1055-1500	245	1, 3	2	3078	2,780	2,790	-	-	-	-	-	-
	1		1055-1500	245	1, 3	2	3077	1,820	1,830	-	-	-	-	-	-
	Backup		1055-1500	245	1, 3	1	2118	6,170	6,180	-	-	-	-	-	-
	Total		1055-1500	245	-	-	-	18,000	18,000	-	-	-	-	-	-

TABLE 6 (concluded)

Sampling Data								Emission Rates d/ (mg/min)							
				Sampling	Samples c/			Total Em. Rate	Total Em. Rate	Pb Em. Rate	Pb Em. Rate	As Em. Rate	As Em. Rate	Cd Em. Rate	Cd Em. Rate
Run No. a/	Location b/	Date	Time	Period (min)	Set	Type	Filter No.	Act. Cond. (mg/min)	Std. Cond. e/ (mg/min)	Act. Cond. (mg/min)	Std. Cond. e/ (mg/min)	Act. Cond. (mg/min)	Std. Cond. e/ (mg/min)	Act. Cond. (mg/min)	Std. Cond. e/ (mg/min)
32	17	7-29-76	1500-0725	985	1, 2	1	2121	136,000	135,000	17,600	17,400	11,500	11,400	269	266
	18	to	1505-0730	985	1, 2	1	2122	201,000	199,000	22,000	21,800	13,300	13,200	577	571
	19	7-30-76	1515-0740	985	1, 2	1	2119	25,300	25,000	1,510	1,500	399	394	1,440	1,420
	20		1520-0745	985	1, 2	1	2120	1,380	1,360	82.7	81.8	13.5	13.4	218	215
33	17	7-30-76	0730-1340	370	1, 2	1	2123	30,500	29,600	9,380	9,090	2,810	2,740	89.1	86.7
	18		0735-1340	365	1, 2	1	2124	32,600	31,700	9,890	9,640	1,650	1,600	154	150
	19-Stage 5		0740-1400	380	1, 2	2	3101	525	510	20.0	19.5	6.16	5.99	49.3	47.9
	4		0740-1400	380	1, 2	2	3100	338	329	26.5	25.7	4.93	4.79	43.1	41.9
	3		0740-1400	380	1, 2	2	3099	184	179	16.9	16.5	1.66	1.62	23.7	23.0
	2		0740-1400	380	1, 2	2	3098	143	139	12.6	12.3	0.80	0.78	7.09	6.88
	1		0740-1400	380	1, 2	2	3097	99.4	96.6	14.	14.4	0.68	0.66	2.93	2.84
	Backup		0740-1400	380	1, 2	1	2125	910	886	43.1	41.9	19.1	18.6	92.5	89.8
	Total		0740-1400	380	-	-	-	2,200	2,130	134	130	33.3	32.3	219	212
	20-Stage 5		0750-1355	365	1, 4	2	3091	98.1	95.4	-	-	-	-	-	-
	4		0750-1355	365	1, 4	2	3090	68.1	66.3	-	-	-	-	-	-
	3		0750-1355	365	1, 4	2	3089	38.6	37.6	-	-	-	-	-	-
	2		0750-1355	365	1, 4	2	3088	27.8	27.1	-	-	-	-	-	-
	1		0750-1355	365	1, 4	2	3087	23.8	23.2	-	-	-	-	-	-
	Backup		0750-1355	365	1, 4	1	2126	214	208	-	-	-	-	-	-
	Total		0750-1355	365	-	-	-	470	457	-	-	-	-	-	-

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a/ Runs 1 through 12 were at Glover, Missouri; Runs 20 through 33 were at East Helena, Montana. There were no Runs 13 through 19.

b/ See Figures 1 and 2. Location 1 had three sampling points. Two (1-Top and 1-Bottom) were on the vertical-profile sampler, and one was a HiVol positioned on the ground at the same height as 1-Bottom. Locations 4A, 5A, 6, 6N, 6S, 23A, 24N, and 24S provided only ambient air background concentrations. Therefore, no emission rates were calculated for these locations.

c/ Sets 1 and 2 were samples analyzed by MRI; Set 3 was analyzed by Physical Electronic Industries in Minneapolis; and Set 4 was analyzed by Walter C. McCrone Associates, Inc., in Chicago. Type 1 are 8 in. by 10 in. glass-fiber filters used in HiVol samplers. Type 2 are 4 in. x 5 in. glass-fiber filters used in the Sierra 5-stage impactor which in turn was used in HiVol samplers or in MRI's vertical-profile sampling apparatus.

d/ Emission rates are given in three significant figures since climatic conditions, velometer measurements, and effective areas are no more accurate. Some Pb, As, and Cd concentrations are not given. This is because no weights were available from sample Sets 3 and 4.

e/ Standard conditions are 77°F and 29.92 in. Hg.

f/ These values were estimated by using the percentage of Pb and As from the back-up filters for other runs, i.e., 62 and 25%, respectively.

g/ Partially broken hood on ventilator accounted for heavy concentration of material on filter. Ventilator directly below filter.

TABLE 7

LEAD AND ARSENIC SPECIES

Sampling Data								Species														
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate[d]	Sulfide[d]	Comments
1	1-Stage 5	7-8-76			1, 3	2	3000									X				X		Trace of PbO_2
	4				1, 3	2	3001									X				X	X	
	3				1, 3	2	3002									X	X			X		
	2				1, 3	2	3003									X				X	X	Trace of PbO_2
	1				1, 3	2	3004									X	X			X	X	PbO_2 on surface only
	Backup				1, 3	1	2007									X	X			X	X	
	Total		1250-1610	200	-	-	-															
	1-Top		0827-0830 1247-1605	3 198	1, 2	1	2003															
	1-Bottom		0827-0830 1247-1605	3 198	1, 4	1	2004		X									X	X			
	2-North		1300-1632	212	1, 2	1	2001															
	2-South		1310-1640	210	1, 2	1	2002															
	3		1303-1530	147	1, 2	1	2005															
	3A		0317-0322 0333-0338 0424-0429	15	1, 4	1	2006		X						X			X	X			
2	1-Stage 5	7-8-76			1, 4	2	3010		X									X	X			
	4	to			1, 4	2	3009		X									X	X			
	3	7-9-76			1, 4	2	3008		X									X	X			
	2				1, 4	2	3007		X									X	X			
	1				1, 4	2	3006		X									X	X			
	Backup				1, 4	1	2015		X									X	X			
	Total		1715-0722	847	-	-	-															
	1-Top		1627-0714	887	1, 2	1	2009															
	1-Bottom		1627-0714	887	1, 2	1	2010															
	2-North		1635-0725	890	1, 2	1	2012															
	2-South		1640-0730	890	1, 2	1	2011															
	3		1650-~1930	160	1, 4	1	2013															
	3A		1700-0800	900	1, 2	1	2014															
3	1-Top	7-9-76	0840-1222	222	1, 2	1	2020															
	1-Bottom		0840-1222	222	1, 2	1	2019															
	2N-Stage 5				1, 2	2	3015															
	4				1, 2	2	3014															
	3				1, 2	2	3013															
	2				1, 2	2	3012															
	1				1, 2	2	3011															
	Backup				1, 2	1	2021															
	Total		1100-1515	255	-	-	-															

TABLE 7 (Continued)

Sampling Data								Species														
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate[d]	Sulfide[d]	Comments
3	2-South	7-9-76	0730-1505	455	1, 4	1	2016	X	X						X			X	X			
	3		0730-1545	495	1, 2	1	2017															
	3A		9, 5-min intervals	45	1, 2	1	2018															
4	2-North	7-9-76	1535-0905	1,050	1, 4	1	2025		X									X	X			
	2-South	to	1540-0905	1,045	1, 2	1	2022															
	3-Stage 5	7-10-76	1547-0900	1,033	1, 2	2	3021															
	4		1547-0900	1,033	1, 2	2	3020															
	3		1547-0900	1,033	1, 2	2	3019															
	2		1547-0900	1,033	1, 2	2	3018															
	1		1547-0900	1,033	1, 2	2	3017															
	Backup		1547-0900	1,033	1, 4	1	2026		X									X	X			
	Total		1547-0900	1,033	-	-	-															
	3		1540-0900	1,044	1, 2	1	2023															
	3A		1555-0900	1,025	1, 2	1	2024															
5	1-Top	7-12-76	0745-1330	345	1, 4	1	2031		X									X	X			
	1-Bottom		0745-1330	345	1, 3	1	2032									X				X		Trace PbO_2
	2-North		0830-1415	345	1, 3	1	2027									X				X		Chloride present
	2-South		0830-1415	345	1, 2	1	2028															
	3		0900-1500	360	1, 3	1	2033									X				X		Trace PbO_2
	3A		0845-1500	375	1, 2	1	2030															
6	4	7-12-76	1600-0915	1,035	1, 4	1	2035		X									X	X			
	5	to 7-13-76	1600-0915	1,035	1, 2	1	2036															
7	4	7-13-76	1300-1545	165	1, 2	1	2037															
	5		1300-1545	165	1, 4	1	2038		X									X	X			
8	4-Stage 5	7-13-76	1600-0730	930	1, 2	2	3027															
	4	to 7-14-76	1600-0730	930	1, 2	2	3028															
	3		1600-0730	930	1, 2	2	3029															
	2		1600-0730	930	1, 2	2	3030															
	1		1600-0730	930	1, 2	2	3031															
	Backup		1600-0730	930	1, 2	1	2045															
	Total		1600-0730	930	-	-	-															
	5		1600-0730	930	1, 3	1	2042									X				X	X	
	6-North		1400-1400	1,440	1, 4	1	2040		X									X	X			
	6-South		1400-1400	1,440	1, 3	1	2039							X		X	X	X		X	X	Chloride present
	6-Overpass		1400-1400	1,440	1, 2	1	2041															

TABLE 7 (Continued)

Sampling Data								Species														
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate[d]	Sulfide[d]	Comments
9	4	7-14-76	0725-1245	320	1, 2	1	2044															
	5	7-14-76	0730-1245	315	1, 2	1	2043															
10	4	7-14-76	1600-0720	920	1, 2	1	2052															
	5-Stage 5	to	1300-1600	180	1, 2	2	3032															
	4	7-15-76	1300-1600	180	1, 2	2	3033															
	3		1300-1600	180	1, 2	2	3034															
	2		1300-1600	180	1, 2	2	3035															
	1		1300-1600	180	1, 2	2	3036															
	Backup		1300-1600	180	1, 2	1	2046															
	Total		1300-1600	180	-	-	-															
	5		1600-0730	930	1, 2	1	2053															
	6-North		1400-0800	1,080	1, 2	1	2048															
	6-South		1400-0800	1,080	1, 2	1	2049															
	6-Overpass		1400-0800	1,080	1, 2	1	2050															
11	4	7-14-76	1230-1600	210	1, 3	1	2047									X				X	X	
12	4A	7-15-76	0720-1300	340	1, 4	1	2057		X									X	X			
	5A		0730-1300	330	1, 4	1	2055											X	X			
	6N-Stage 5		1245-1430	105	1, 2	2	3037															
	4		1245-1430	105	1, 2	2	3038															
	3		1245-1430	105	1, 2	2	3039															
	2		1245-1430	105	1, 2	2	3040															
	1		1245-1430	105	1, 2	2	3041															
	Backup		1245-1430	105	1, 2	1	2054															
	Total		1245-1430	105	-	-	-															
	6-North		0800-1245	285	1, 2	1	2059															
	6-South		0800-1430	390	1, 2	1	2060															
	6-Overpass		0800-1415	375	1, 2	1	2056															
20	11	7-22-76	1530-0744	974	1, 2	1	2061															
	12	to	1530-0754	994	1, 2	1	2062															
	13	7-23-76	1550-0738	948	1, 2	1	2063															
	14		1520-0740	980	1, 2	1	2064															
	15		1530-0800	990	1, 2	1	2065															
	16		1515-0730	995	1, 2	1	2066															
21	11-Stage 5	7-23-76	0752-1510	438	1, 3	2	3046							X		X				X		
	4		0752-1510	438	1, 3	2	3045							X		X				X		
	3		0752-1510	438	1, 3	2	3044							X		X				X		
	2		0752-1510	438	1, 3	2	3043							X		X				X		
	1		0752-1510	438	1, 3	2	3042							X		X				X		
	Backup		0752-1510	438	1, 3	1	2069							X		X				X		
	Total		0752-1510	438	-	-	-															
	12		0807-1520	433	1, 4	1	2070		X									X	X			
	13-Stage 5		0742-1540	478	1, 4	2	3051								X			X	X			
	4		0742-1540	478	1, 4	2	3050	X							X			X	X			
	3		0742-1540	478	1, 4	2	3049	X	X						X			X	X			

TABLE 7 (Continued)

Sampling Data								Species														
Run No.[a/]	Location[b/]	Date	Time	Sampling Period (min)	Samples[c/] Set	Samples[c/] Type	Filter No.	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate[d/]	Sulfide[d/]	Comments
	13-Stage 2	7-23-76	0742-1540	478	1, 4	2	3048	X	X						X			X	X			
	1		0742-1540	478	1, 4	2	3047	X	X						X			X	X			
	Backup		0742-1540	478	1, 4	1	2071		X			X						X	X			
	Total		0742-1540	478	-	-	-															
	14		0750-1526	456	1, 4	1	2072		X						X			X	X			
	15		0800-1508	428	1, 4	1	2073		X						X			X	X			
	16		0740-1519	459	1, 4	1	2074		X						X			X	X			
22	11	7-23-76 to 7-24-76	1515-1140	985	1, 3	1	2077															
	12		1530-0745	975	1, 2	1	2078															
	13		1540-0750	970	1, 2	1	2079															
	14A		1547-0735	948	1, 2	1	2075															
	15		1514-0730	976	1, 2	1	2076															
	16		1523-0732	969	1, 2	1	2080															
23	21	7-26-76	1005-1445	280	1, 4	1	2081	X										X	X			
	22		1220-1450	150	1, 4	1	2086	X	X	X								X	X			
	23		1030-1457	267	1, 4	1	2082	X	X						X			X	X			
	23A		1315-1505	110	1, 4	1	2087	X	X	X								X	X			
	24-North		1035-1515	280	1, 4	1	2083	X	X									X	X			
	24-South		1040-1520	280	1, 4	1	2084	X	X									X	X			
24	23	7-26-76 to 7-27-76	1501-0750	1,009	1, 2	1	2089															
	23A		1510-0800	1,010	1, 2	1	2090															
25	21	7-27-76	0730-1425	415	1, 2	1	2096															
	22		0735-1430	415	1, 2	1	2097															
	23		0753-1045	172	1, 2	1	2098															
	23A		0802-1100	178	1, 3	1	2099															
	24-North		0820-1500	400	1, 3	1	2100															
	24-South		0810-1510	420	1, 3	1	2101															
26	23-Stage 5		1055-1445	410	1, 4	2	3056	X	X									X	X			
	4		1055-1445	410	1, 4	2	3055	X	X						X			X	X			
	3		1055-1445	410	1, 4	2	3054	X	X						X			X	X			
	2		1055-1445	410	1, 4	2	3053	X	X						X			X	X			
	1		1055-1445	410	1, 4	2	3052	X	X										X			
	Backup		1055-1445	410	1, 4	1	2091	X	X						X			X	X			
	Total		1055-1445	410	-	-	-															
	23A-Stage 5		1100-1450	230	1, 2	2	3061															
	4		1100-1450	230	1, 2	2	3060															
	3		1100-1450	230	1, 2	2	3059															
	2		1100-1450	230	1, 2	2	3058															
	1		1100-1450	230	1, 2	2	3057															
	Backup		1100-1450	230	1, 2	2	2092															
	Total		1100-1450	230	-	-	-															

TABLE 7 (Continued)

Sampling Data								Species														
Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate[d]	Sulfide[d]	Comments
27	17	7-27-76	1530-0930	1,080	1, 2	1	2095															
	18	to	1530-0920	1,070	1, 2	1	2102															
	23	7-28-76	1447-0725	998	1, 2	1	2093															
	23A		1455-0700	1,005	1, 2	1	2094															
28	17	7-28-76	0935-1505	330	1, 4	1	2106		X						X			X	X			
	18		0925-1510	345	1, 4	1	2107	X	X						X			X	X			
	19		0850-1530	400	1, 4	1	2103	X	X						X			X	X			
	20		0900-1530	390	1, 4	1	2104	X	X						X			X	X			
29	17-Stage 5	7-28-76	1515-0745	990	1, 3	2	3066									X				X		As at > 1% detected
	4	to	1515-0745	990	1, 3	2	3065							X		X				X		As at > 1% detected
	3	7-29-76	1515-0745	990	1, 3	2	3064									X				X		As at > 1% detected
	2		1515-0745	990	1, 3	2	3063							X		X				X		As at > 1% detected
	1		1515-0745	990	1, 3	2	3062							X		X				X		As at > 1% detected
	Backup		1515-0745	990	1, 3	1	2108							X		X				X		As at > 1% detected
	Total		1515-0745	990	-	-	-															
	18-Stage 5		1520-0740	980	1, 4	2	3071	X										X	X			
	4		1520-0740	980	1, 4	2	3070	X							X			X	X			
	3		1520-0740	980	1, 4	2	3069	X							X			X	X			
	2		1520-0740	980	1, 4	2	3068	X	X						X			X	X			
	1		1520-0740	980	1, 4	2	3067	X	X						X			X	X			
	Backup		1520-0740	980	1, 4	1	2109	X	X						X			X	X			
	Total		1520-0740	980	-	-	-															
	19		1530-0810	1,000	1, 2	1	2110															
	20		1535-0815	1,000	1, 2	1	2111															
30	17	7-29-76	0747-1035	168	1, 2	1	2112															
	18		0745-1050	185	1, 3	1	2113															
	19		0815-1510	415	1, 2	1	2114															
	20		0817-1520	423	1, 2	1	2115															
31	17-Stage 5	7-29-76	1040-1455	255	1, 4	2	3006	X							X			X				
	4		1040-1455	255	1, 4	2	3085	X										X	X			
	3		1040-1455	255	1, 4	2	3084	X	X						X			X				
	2		1040-1455	255	1, 4	2	3083								X			X				
	1		1040-1455	255	1, 4	2	3082								X			X				
	Backup		1040-1455	255	1, 4	1	2117				X				X			X	X			
	Total		1040-1455	255	-	-	-															
	18-Stage 5		1055-1500	245	1, 3	2	3081															
	4		1055-1500	245	1, 3	2	3080															
	3		1055-1500	245	1, 3	2	3079															
	2		1055-1500	245	1, 3	2	3078															
	1		1055-1500	245	1, 3	2	3077															
	Backup		1055-1500	245	1, 3	1	2118															
	Total		1055-1500	245	-	-	-															

TABLE 7 (Concluded)

Run No.[a]	Location[b]	Date	Time	Sampling Period (min)	Samples[c] Set	Samples[c] Type	Filter No.	Species ZnO	ZnS	$CaCO_3$	As_2O_3	$CaSO_4$	CdO	Zn	Pb	PbO	PbO_2	PbS	$PbSO_4$	Sulfate[d]	Sulfide[d]	Comments
32	17	7-29-76	1500-0725	985	1, 2	1	2121															
	18	to	1505-0730	985	1, 2	1	2122															
	19	7-30-76	1515-0740	985	1, 2	1	2119															
	20		1520-0745	985	1, 2	1	2120															
33	17	7-30-76	0730-1340	370	1, 2	1	2123															
	18		0735-1340	365	1, 2	1	2124															
	19 Stage 5		0740-1400	380	1, 2	2	3101															
	4		0740-1400	380	1, 2	2	3100															
	3		0740-1400	380	1, 2	2	3099															
	2		0740-1400	380	1, 2	2	3098															
	1		0740-1400	380	1, 2	2	3097															
	Backup		0740-1400	380	1, 2	1	2125															
	Total		0740-1400	380	-	-	-															
	20 Stage 5		0750-1355	365	1, 4	2	3091	X	X				X		X				X			
	4		0750-1355	365	1, 4	2	3090	X	X				X		X				X			
	3		0750-1355	365	1, 4	2	3089	X					X	X	X			X	X			
	2		0750-1355	365	1, 4	2	3088	X	X				X		X			X	X			
	1		0750-1355	365	1, 4	2	3087	X	X						X			X	X			
	Backup		0750-1355	365	1, 4	1	2126	X	X													
	Total		0750-1355	365	-	-	-															

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a/ Runs 1 through 12 were at Glover, Missouri. Runs 20 through 33 were at East Helena, Montana. There were no Runs 13 through 19.

b/ See Figures 1 and 2. Location 1 had three sampling points. Two (1-Top and 1-Bottom) were on the vertical-profile sampler, and one was a HiVol positioned on the ground at the same height as 1-Bottom.

c/ Sets 1 and 2 were samples analyzed by MRI; Set 3 was analyzed by Physical Electronic Industries in Minneapolis; and Set 4 was analyzed by Walter C. McCrone Associates, Inc., in Chicago. Type 1 are 8 in. x 10 in., glass-fiber filters used in HiVol samplers. Type 2 are 4 in. x 5 in., glass-fiber filters used in the Sierra 5-stage impactor, which in turn was used in HiVol samplers or in MRI's vertical-profile sampling apparatus.

d/ Sulfate and sulfite not associated with Pb except Run 8, Location 6 South.

APPENDIX A

DRAWINGS OF THE ASARCO PLANT, GLOVER, MISSOURI

(Sampling locations are identified)

DRAWINGS OF THE ASARCO PLANT, GLOVER, MISSOURI

Sampling Locations		
No.	Point	Figure
1	North end of Sinter Bldg.	A-1 to A-6, A-8, A-9, A-12
2N	Roof opening of Sinter Bldg.	A-1 to A-5, A-9, A-11, A-12
2S	Roof opening of Sinter Bldg.	A-1 to A-5, A-9, A-11, A-12
3	Outside, north of blast furnace tapping operation	A-1 to A-5, A-13, A-14
3A	East of blast furnace	A-1 to A-5, A-13
4	Inside, north of charge feed position of blast furnace	A-1 to A-5, A-13, A-14
4A	Outside, west of charge inlet to blast furnace	A-1 to A-5, A-13
5	North of ore storage bins	A-1 to A-6, A-15
5A	West of ore storage bins	A-1 to A-6, A-15
6	On truck to rail car ore transfer bridge	A-1, A-3
6N	Ground level north of transfer bridge	A-1, A-3
6S	Ground level south of transfer bridge	A-1, A-3

Figure — Title — Page

A-1 Perspective View of Plant, Indicating Locations 1 to 6S . . A-4

A-2 Perspective View of Plant, Indicating Locations 1 to 5A . . A-5

A-3 General Plant Plan View, Indicating Locations 1 to 6S . . . A-6

A-4 Plan View of Main Building, with Dimensions, Indicating Locations 1 to 5A A-7

A-5 Detailed Measurements Locating Sampling Locations 1 to 5A A-8

A-6 Detail, North Side of Building, Indicating Locations 1, 5, and 5A. A-9

A-7 Detail, South Side of Building. A-10

Figure	Title	Page
A-8	Detail, Location 1.	A-11
A-9	Detail, East Side of Sinter Building, Indicating Locations 1 to 2S	A-12
A-10	Detail, South Side of Sinter Building	A-13
A-11	Detail, Roof of Sinter Building, Indicating Locations 2N and 2S	A-14
A-12	Detail, Plan Interior of Sinter Building, Indicating Locations 1 to 2S	A-15
A-13	Detail, East Side of Dross-Kettle/Blast-Furnace Area, Indicating Locations 3 to 4A.	A-16
A-14	Detail, Blast-Furnace Area, Indicating Locations 3 and 4.	A-17
A-15	Detail, Ore-Bin Area, Indicating Locations 5 and 5A	A-18
A-16	View to the South Interior of Dross-Operations Buildings, Blast	A-19
A-17	Detail, Back Side of Sinter Building (Side D) to Dross-Operations Building (Side F).	A-20
A-18	Sampling Locations 6N, 6S, 6 Overpass, Overhead View.	A-21
A-19	Sampling Location 6, Detail	A-22

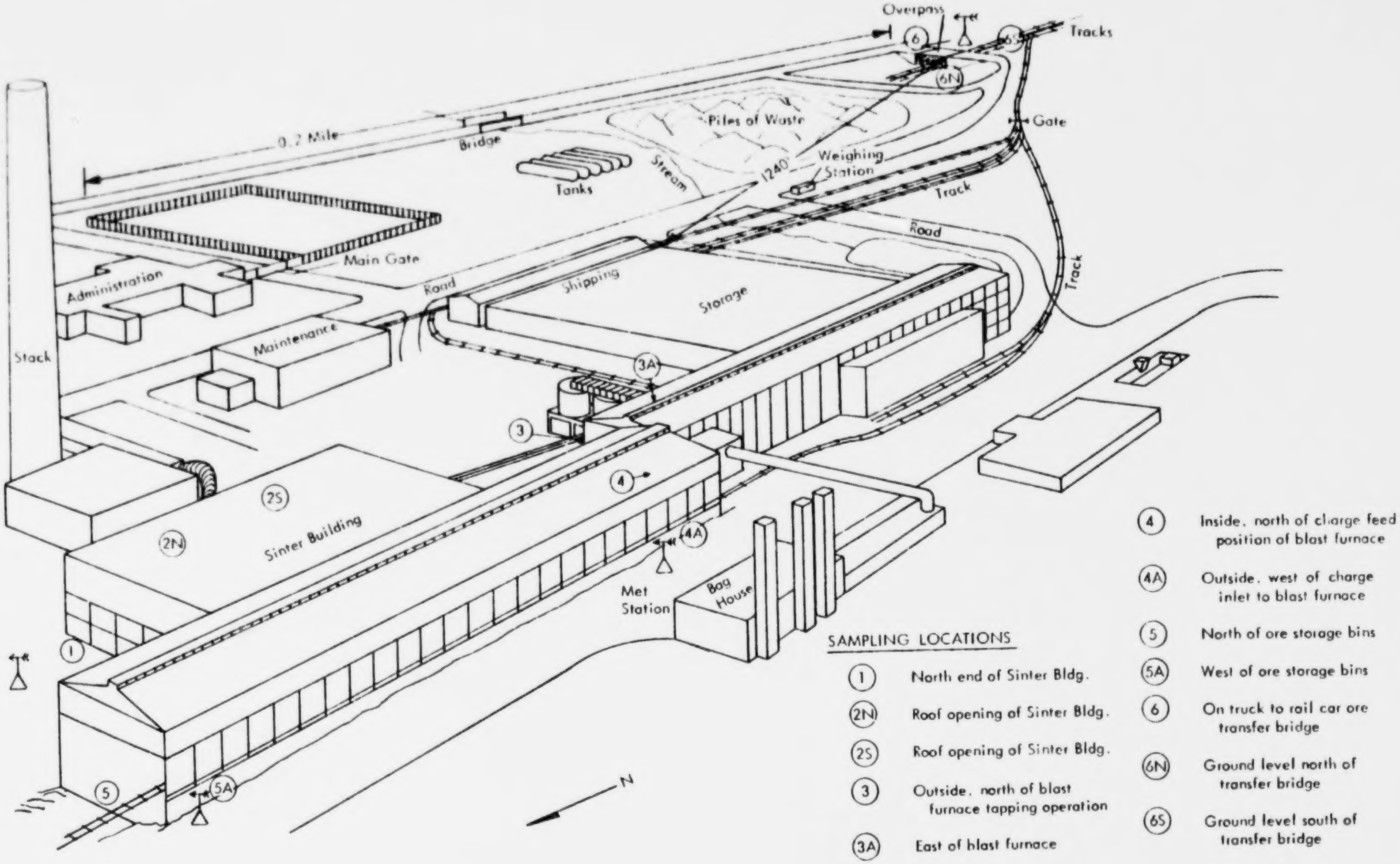

Overpass
Tracks
0.2 Mile
Bridge
Piles of Waste
Tanks
Stream
1240
Weighing Station
Gate
Track
Road
Track
Stack
Administration
Main Gate
Road
Shipping
Storage
Maintenance
Sinter Building
Met Station
Bag House
N
1
2N
2S
3
3A
4
4A
5
5A
6
6N
6S
SAMPLING LOCATIONS
1 North end of Sinter Bldg.
2N Roof opening of Sinter Bldg.
2S Roof opening of Sinter Bldg.
3 Outside, north of blast furnace tapping operation
3A East of blast furnace
4 Inside, north of charge feed position of blast furnace
4A Outside, west of charge inlet to blast furnace
5 North of ore storage bins
5A West of ore storage bins
6 On truck to rail car ore transfer bridge
6N Ground level north of transfer bridge
6S Ground level south of transfer bridge

Figure A-1 - View to the Southeast Showing Locations 1 to 6S

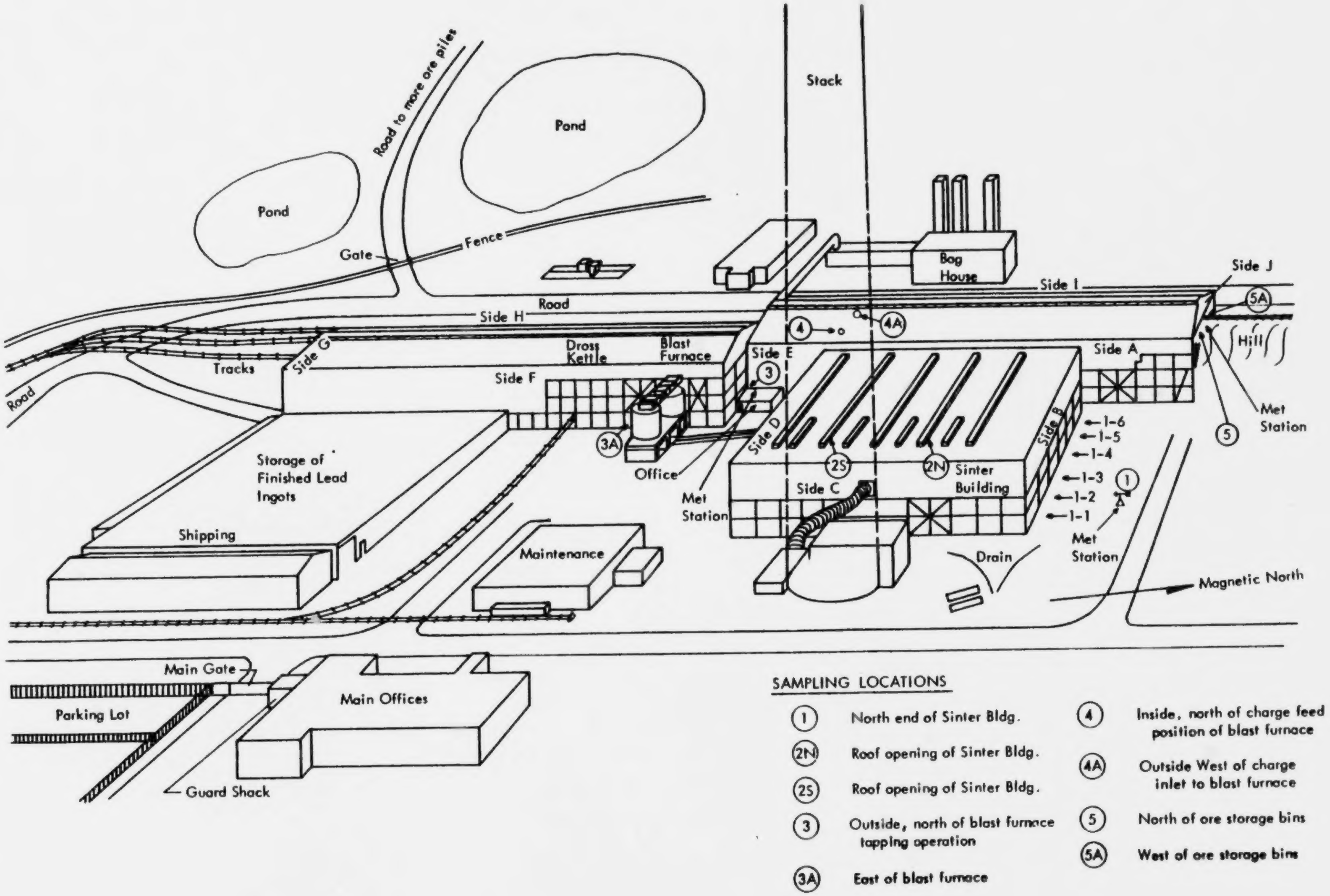
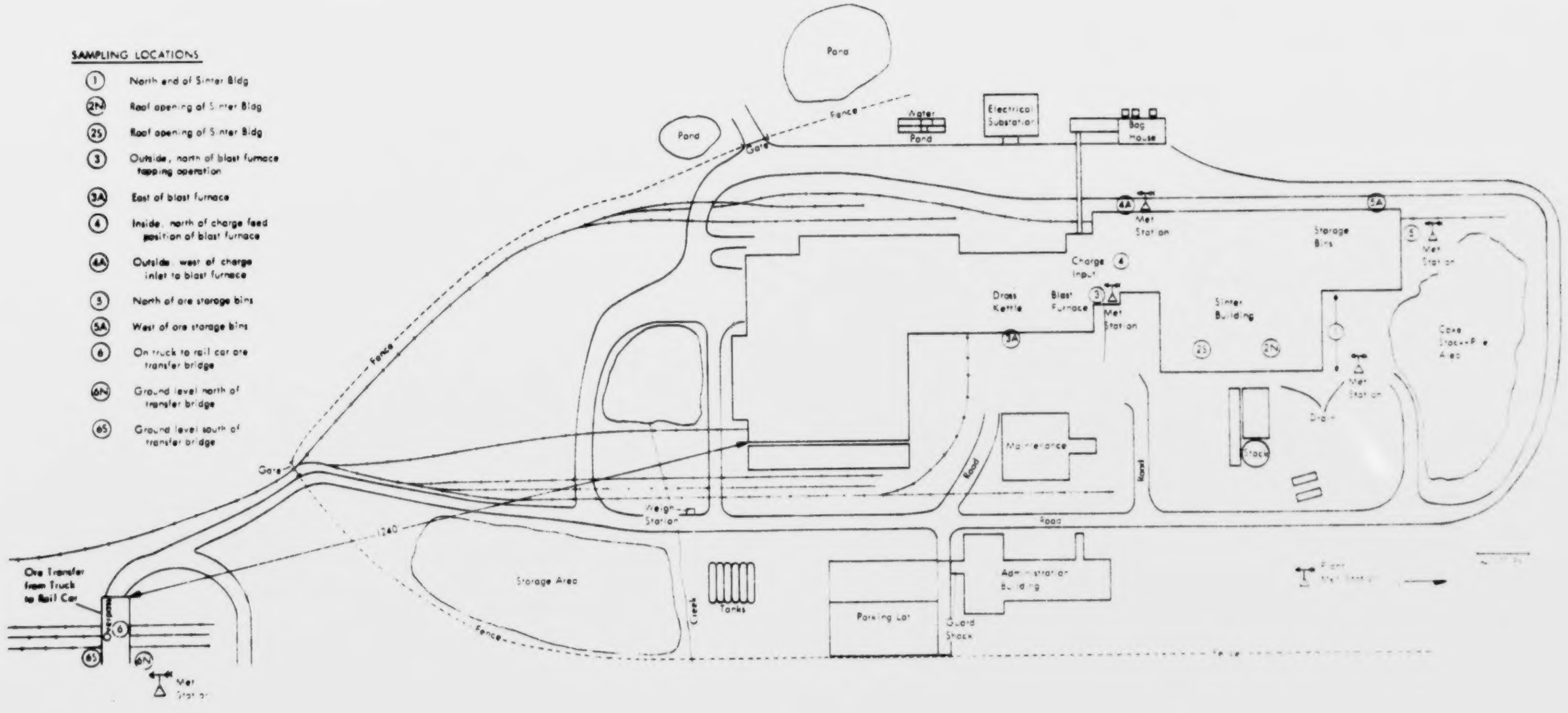

Stack
Pond
Pond
Road to more ore piles
Gate
Fence
Bag House
Side I
Side J
5A
Hill
Road
Side H
4
4A
Side G
Tracks
Road
Dross Kettle
Blast Furnace
Side E
3
Side A
Side F
Side D
Side B
1-6
1-5
1-4
1-3
1-2
1-1
1
5
Met Station
3A
Office
Met Station
2S
2N
Sinter Building
Side C
Met Station
Storage of Finished Lead Ingots
Shipping
Maintenance
Drain
Magnetic North
Main Gate
Parking Lot
Main Offices
Guard Shack
SAMPLING LOCATIONS
1 North end of Sinter Bldg.
2N Roof opening of Sinter Bldg.
2S Roof opening of Sinter Bldg.
3 Outside, north of blast furnace tapping operation
3A East of blast furnace
4 Inside, north of charge feed position of blast furnace
4A Outside West of charge inlet to blast furnace
5 North of ore storage bins
5A West of ore storage bins

Figure A-2 - Perspective View of Plant, Indicating Locations 1 to 5A



SAMPLING LOCATIONS
1 North end of Sinter Bldg
2N Roof opening of Sinter Bldg
2S Roof opening of Sinter Bldg
3 Outside, north of blast furnace tapping operation
3A East of blast furnace
4 Inside, north of charge feed position of blast furnace
4A Outside, west of charge inlet to blast furnace
5 North of ore storage bins
5A West of ore storage bins
6 On truck to rail car ore transfer bridge
6N Ground level north of transfer bridge
6S Ground level south of transfer bridge
Pond
Pond
Fence
Gate
Water Pond
Electrical Substation
Bag House
Met Station
Storage Bins
Charge Input
Dross Kettle
Blast Furnace
Sinter Building
Coke Stock-Pile Area
Drain
Stack
Maintenance
Road
Weigh Station
Storage Area
Creek
Tanks
Parking Lot
Guard Shack
Administration Building
1240
Ore Transfer from Truck to Rail Car
Overpass
Plant Met Station

Figure A-3 - General Plant Plan View, Indicating Locations 1 to 6S

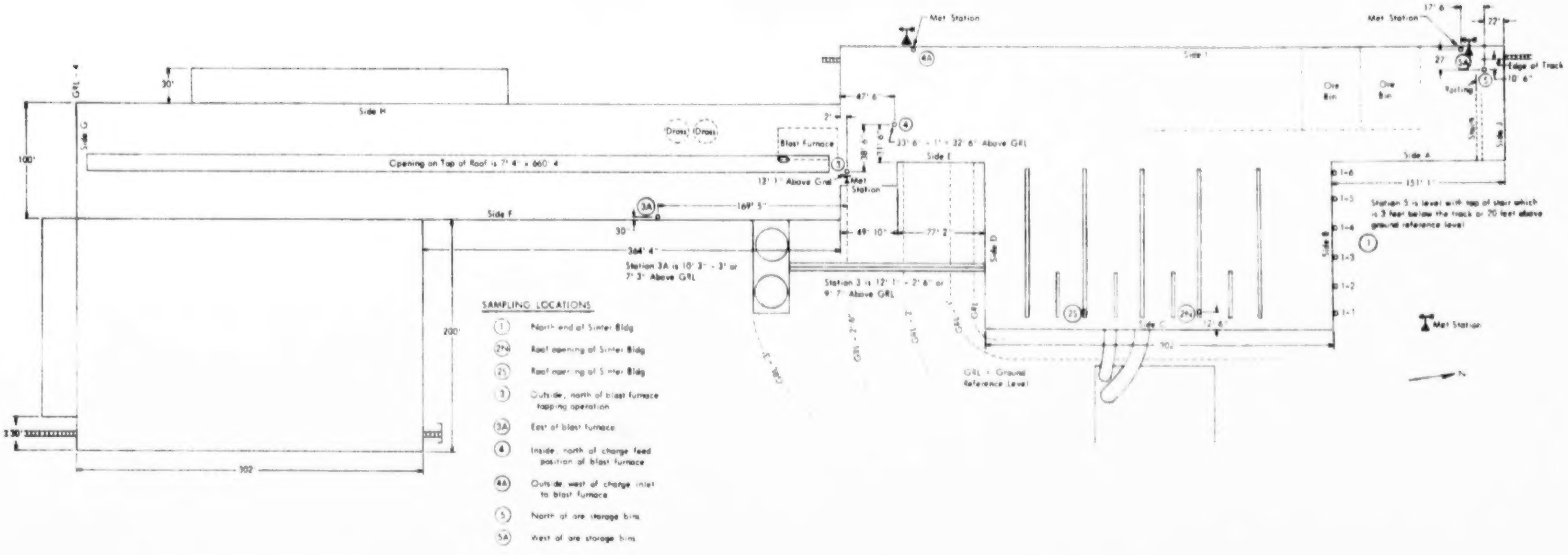

Met Station
Met Station
Met Station
Met Station
17' 6
22'
Side I
27
Edge of Track
10' 6"
Railing
Ore Bin
Ore Bin
Side J
Side A
151' 1"
Station 5 is level with top of stair which is 3 feet below the track or 20 feet above ground reference level
1-1
1-2
1-3
1-4
1-5
1-6
Side B
12' 6"
Side C
302
GRL = Ground Reference Level
Side D
Side E
47' 6
2'
33' 6 - 1' = 32' 6" Above GRL
38' 6
31' 6
Blast Furnace
12' 1" Above Grd
49' 10"
77' 2
Station 3 is 12' 1" - 2' 6" or 9' 7" Above GRL
GRL
GRL - 1'
GRL - 2'
GRL - 2' 6"
GRL - 3'
(Dross) (Dross)
Opening on Top of Roof is 7' 4" x 660' 4
Side H
Side G
GRL - 4
30'
100'
Side F
169' 5"
30"
384' 4"
Station 3A is 10' 3" - 3' or 7' 3" Above GRL
200'
302
3 30'
SAMPLING LOCATIONS
1 North end of Sinter Bldg
2N Roof opening of Sinter Bldg
2S Roof opening of Sinter Bldg
3 Outside, north of blast furnace tapping operation
3A East of blast furnace
4 Inside, north of charge feed position of blast furnace
4A Outside west of charge inlet to blast furnace
5 North of ore storage bins
5A West of ore storage bins
N

Figure A-4 - Plan View of Main Building, with Dimensions, Indicating Locations 1 to 5A

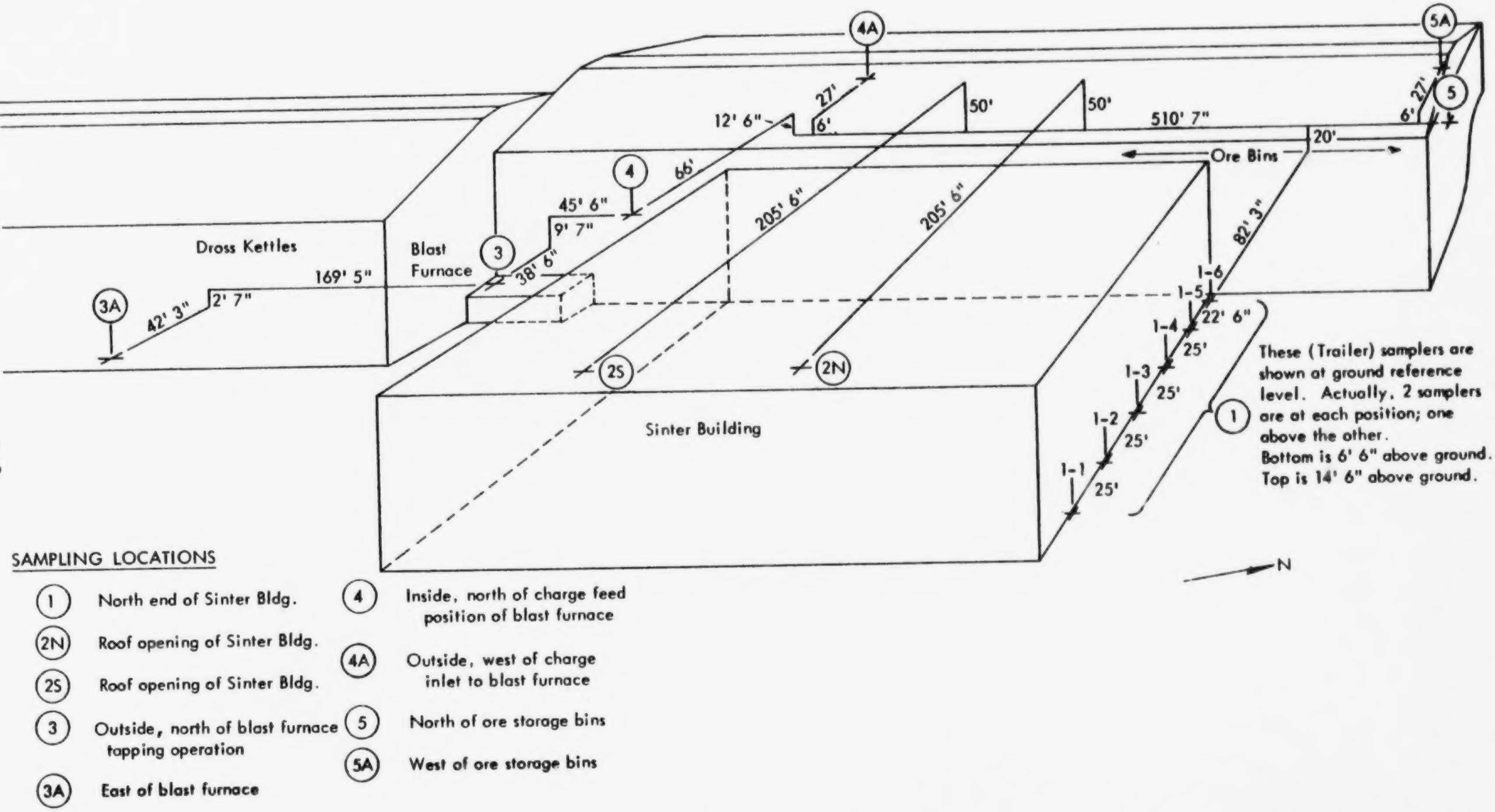

4A
5A
27'
6'
12' 6"
50'
50'
510' 7"
27'
5
6'
20'
Ore Bins
4
66'
45' 6"
9' 7"
205' 6"
205' 6"
82' 3"
Dross Kettles
Blast Furnace
3
38' 6"
169' 5"
3A
42' 3"
2' 7"
1-6
1-5
22' 6"
1-4
25'
1-3
25'
1-2
25'
1-1
25'
2S
2N
Sinter Building
1
These (Trailer) samplers are shown at ground reference level. Actually, 2 samplers are at each position; one above the other.
Bottom is 6' 6" above ground.
Top is 14' 6" above ground.
N
SAMPLING LOCATIONS
1 North end of Sinter Bldg.
2N Roof opening of Sinter Bldg.
2S Roof opening of Sinter Bldg.
3 Outside, north of blast furnace tapping operation
3A East of blast furnace
4 Inside, north of charge feed position of blast furnace
4A Outside, west of charge inlet to blast furnace
5 North of ore storage bins
5A West of ore storage bins

Figure A-5 - Detailed Measurements Locating Sampling Locations 1 to 5A

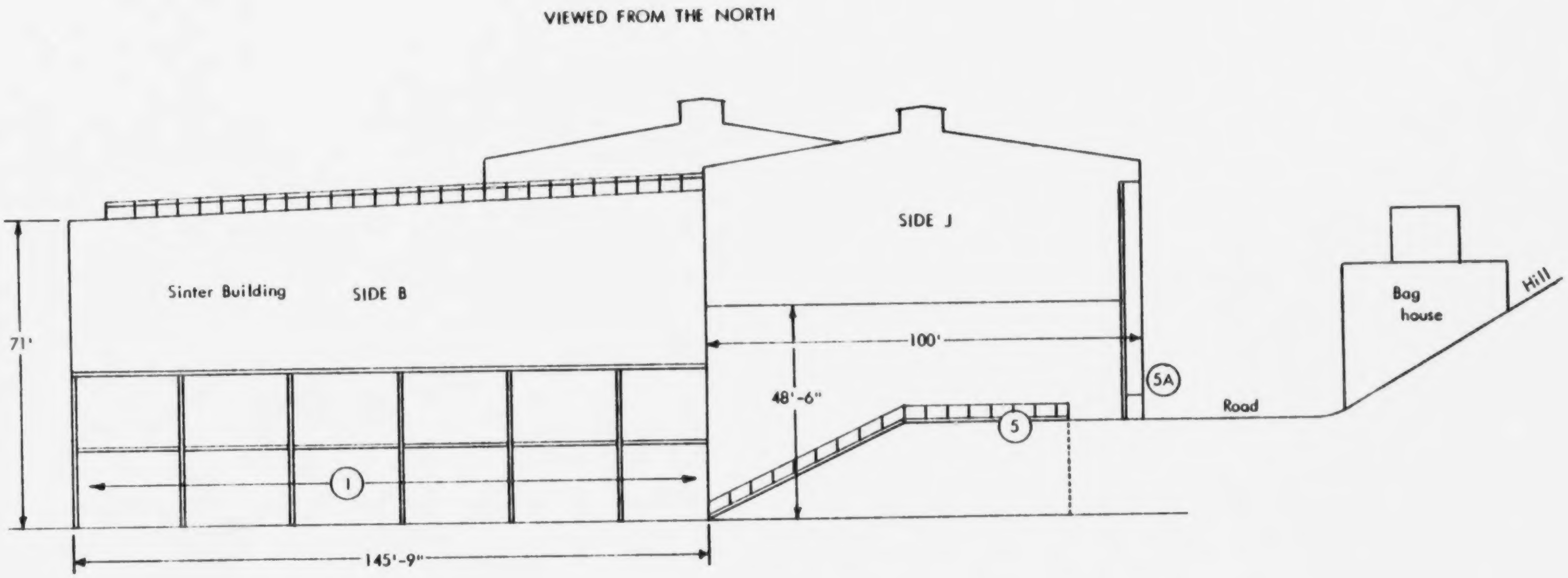

VIEWED FROM THE NORTH
Sinter Building
SIDE B
SIDE J
71'
145'-9"
100'
48'-6"
1
5
5A
Road
Bag house
Hill

Figure A-6 - Detail, North Side of Building, Indicating Locations 1, 5, and 5A

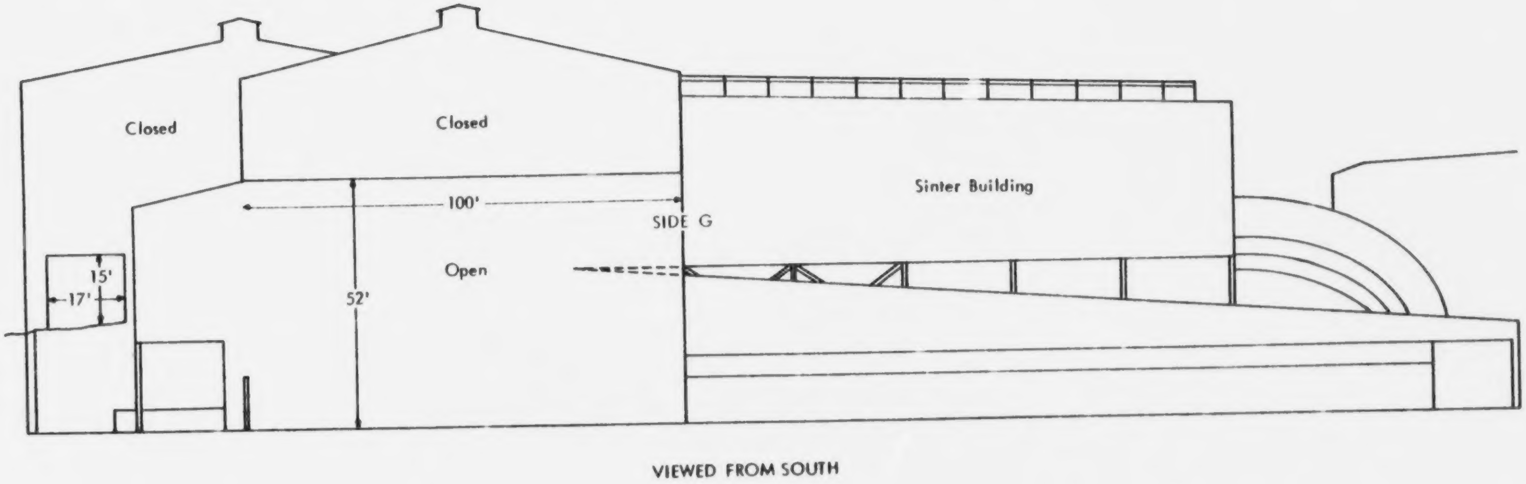
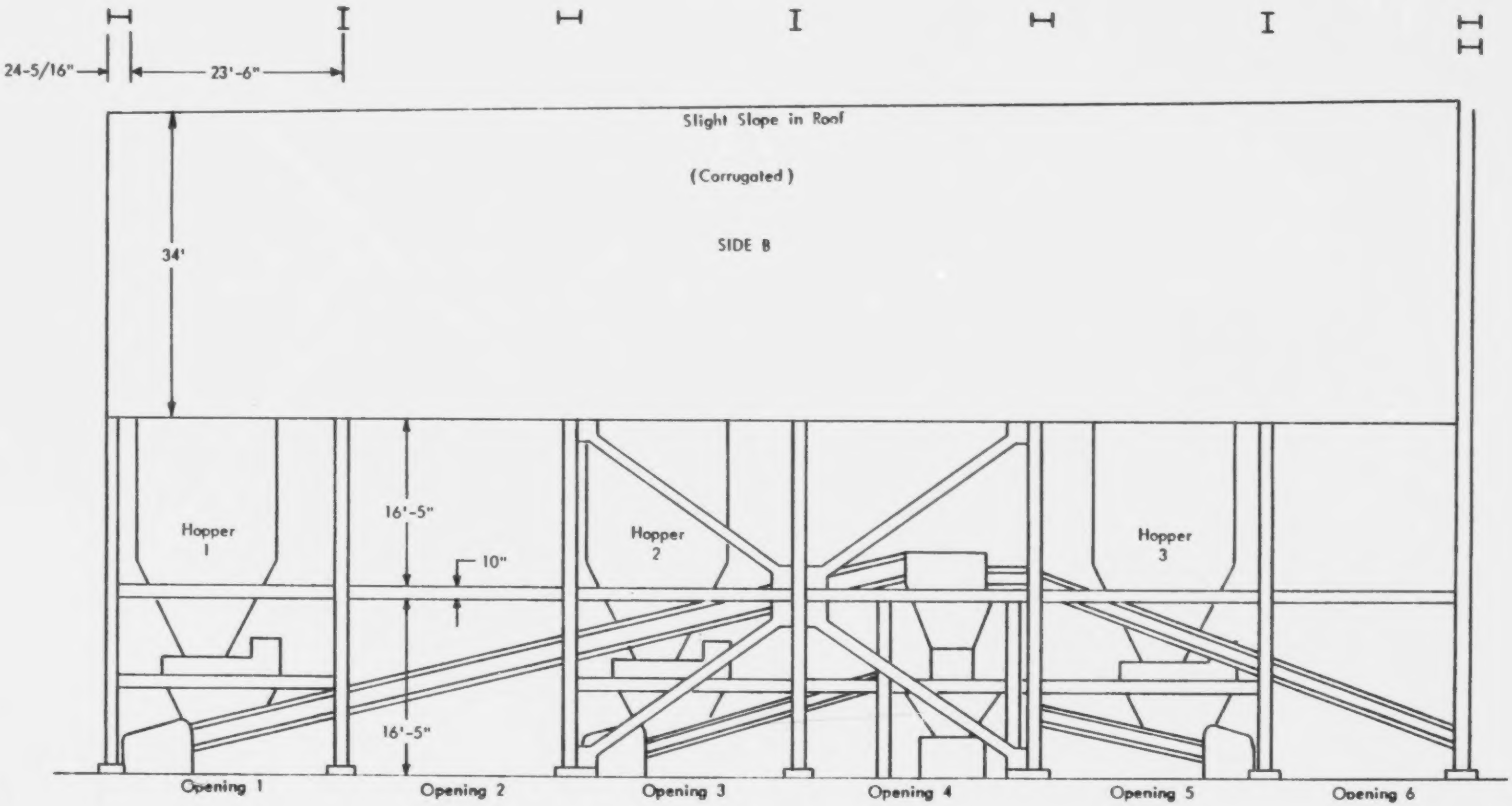

Closed
Closed
Sinter Building
100'
SIDE G
15'
17'
52'
Open
VIEWED FROM SOUTH

Figure A-7 - Detail, South Side of Building



24-5/16"
23'-6"
34'
Slight Slope in Roof
(Corrugated)
SIDE B
16'-5"
10"
16'-5"
Hopper 1
Hopper 2
Hopper 3
Opening 1
Opening 2
Opening 3
Opening 4
Opening 5
Opening 6

Figure A-8 - Detail, Location 1

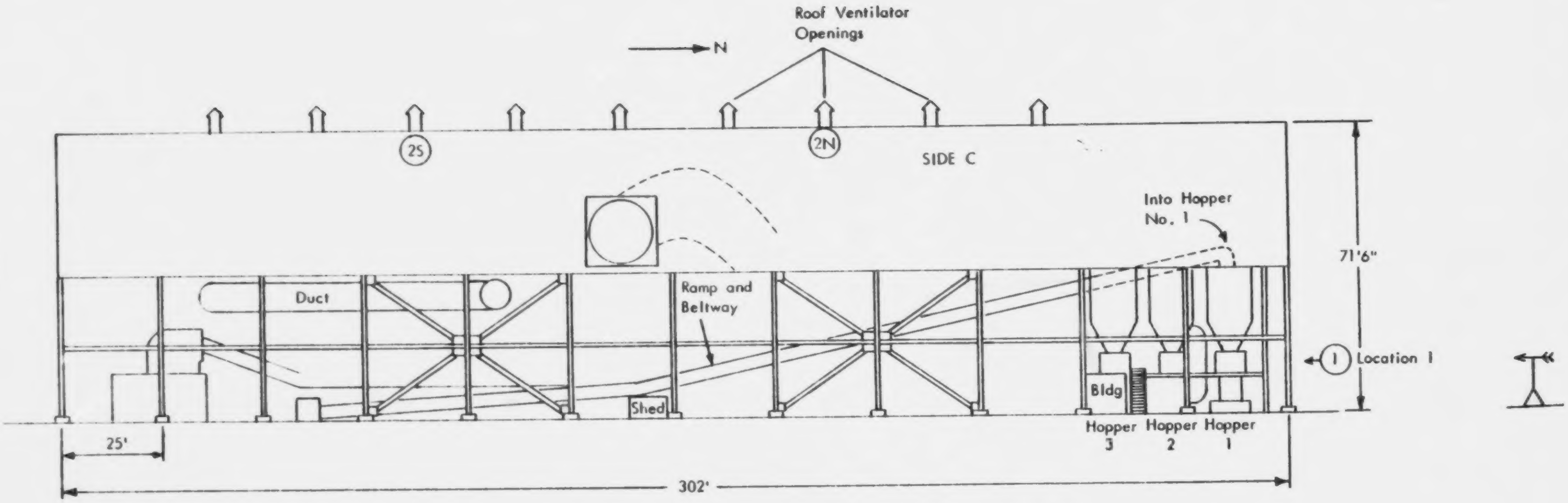

Roof Ventilator Openings
N
2S
2N
SIDE C
Into Hopper No. 1
Duct
Ramp and Beltway
Shed
Bldg
1 Location 1
71'6"
Hopper 3
Hopper 2
Hopper 1
25'
302'

Figure A-9 - Detail, East Side of Sinter Building, Indicating Locations 1 to 2S

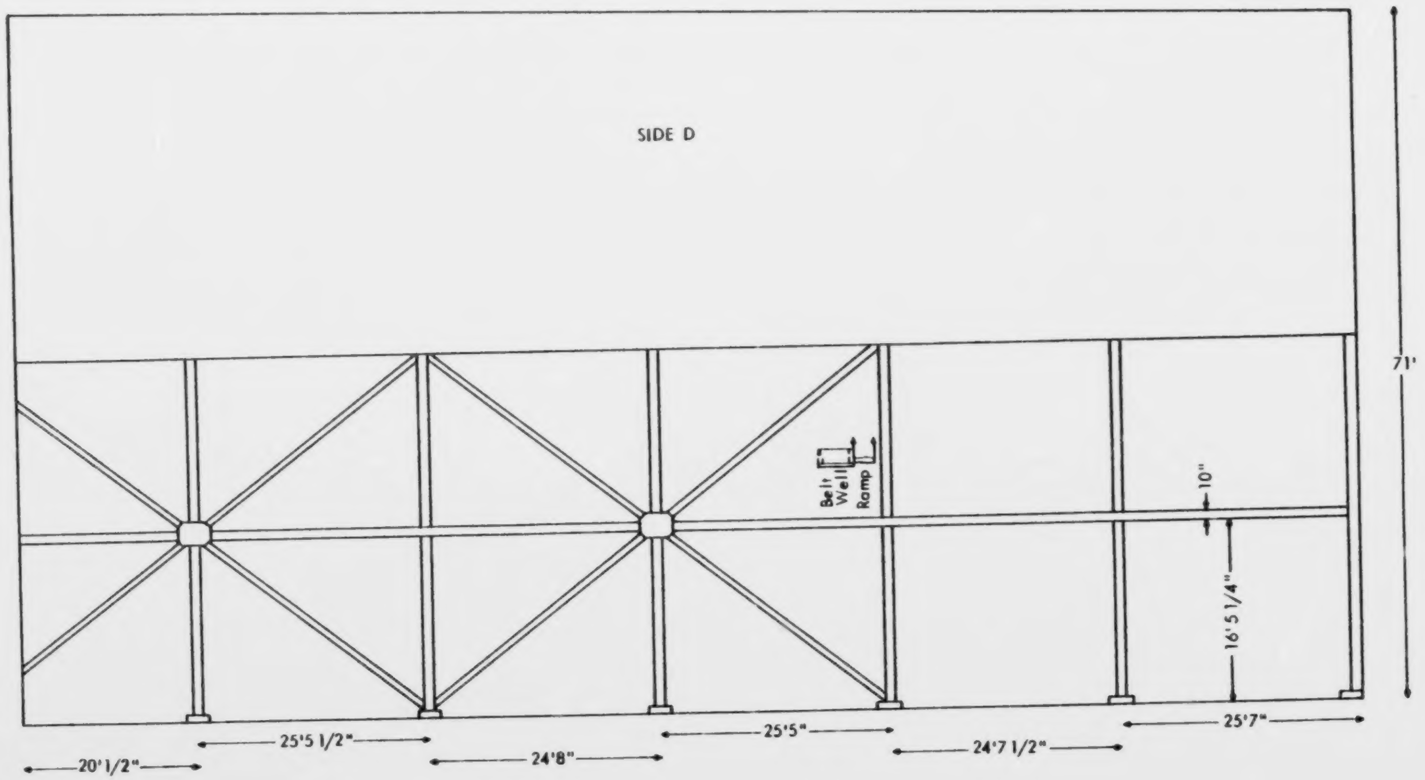

SIDE D
71'
10"
16'5 1/4"
Belt Well Ramp
20'1/2"
25'5 1/2"
24'8"
25'5"
24'7 1/2"
25'7"

Figure A-10 - Detail, South Side of Sinter Building

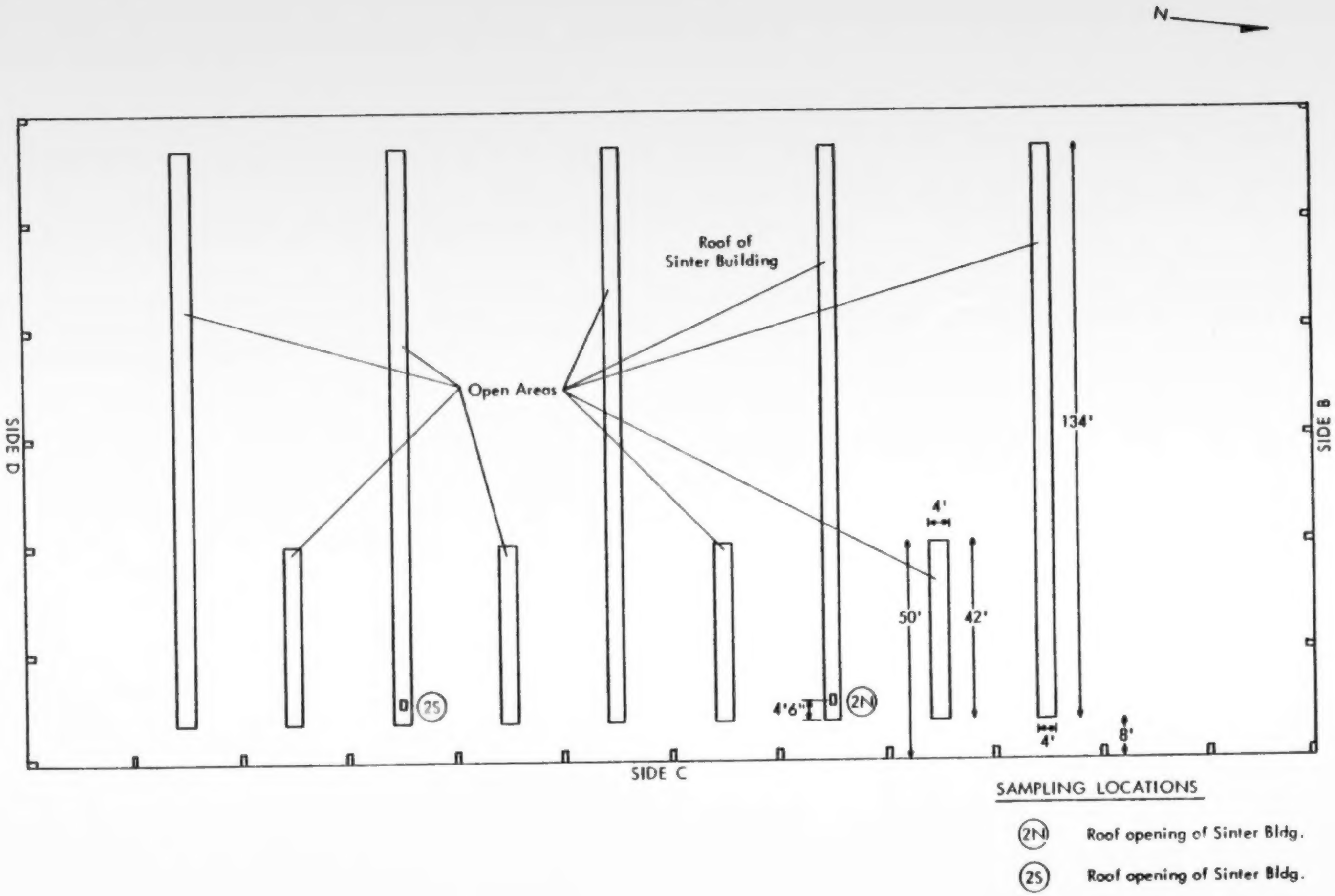

N
Roof of Sinter Building
Open Areas
SIDE D
SIDE B
SIDE C
134'
4'
50'
42'
4'
8'
4'6"
2N
2S
SAMPLING LOCATIONS
2N Roof opening of Sinter Bldg.
2S Roof opening of Sinter Bldg.

Figure A-11 - Detail, Roof of Sinter Building, Indicating Locations 2N and 2S

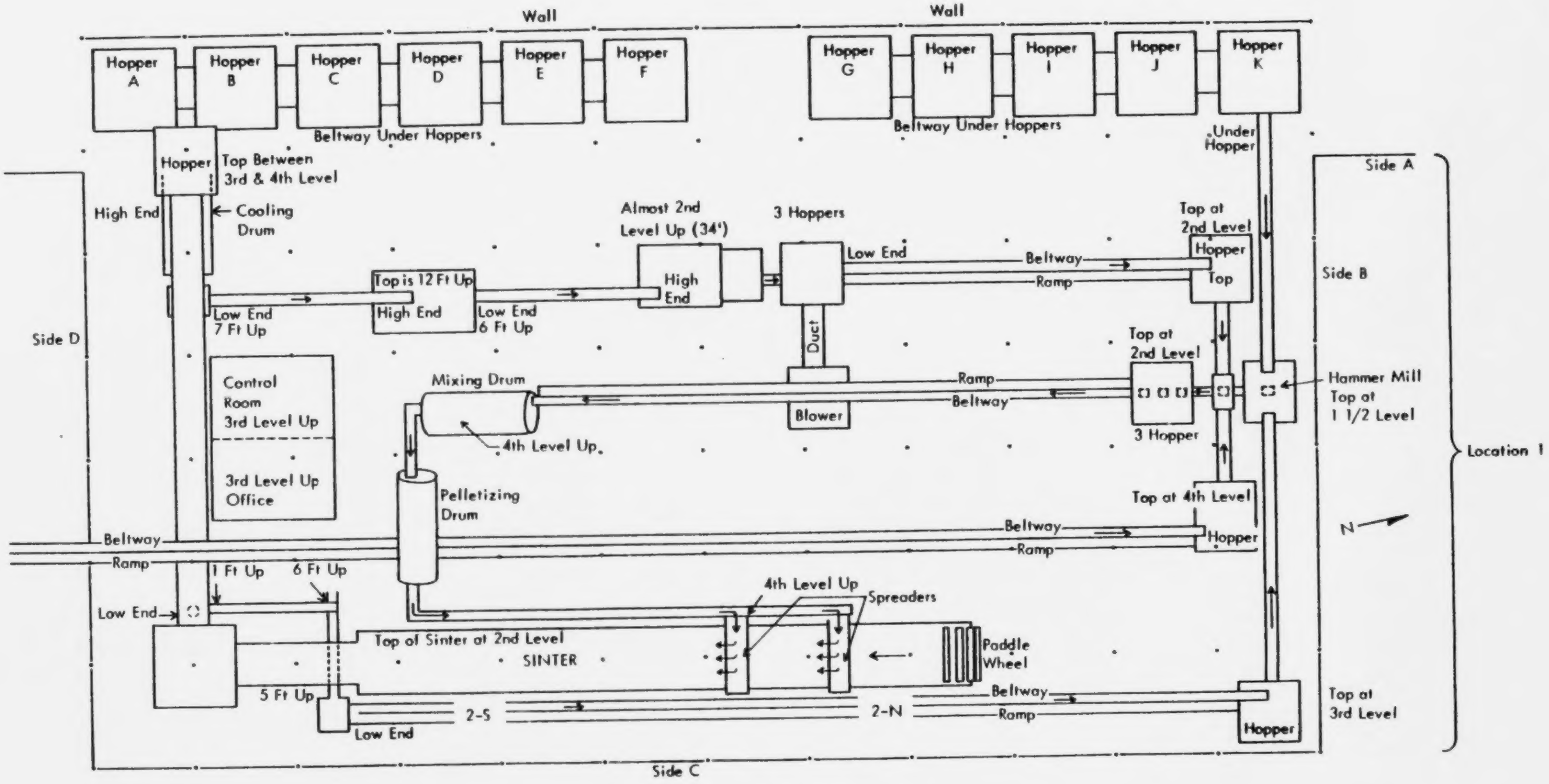

Wall
Wall
Hopper A
Hopper B
Hopper C
Hopper D
Hopper E
Hopper F
Hopper G
Hopper H
Hopper I
Hopper J
Hopper K
Beltway Under Hoppers
Beltway Under Hoppers
Under Hopper
Hopper
Top Between 3rd & 4th Level
High End
Cooling Drum
Almost 2nd Level Up (34')
3 Hoppers
Low End
Beltway
Ramp
Top at 2nd Level
Hopper
Top
Side A
Side B
Top is 12 Ft Up
High End
Low End 7 Ft Up
Low End 6 Ft Up
High End
Duct
Side D
Control Room 3rd Level Up
3rd Level Up Office
Mixing Drum
4th Level Up.
Ramp
Beltway
Blower
Top at 2nd Level
3 Hopper
Hammer Mill Top at 1 1/2 Level
Location 1
Pelletizing Drum
Top at 4th Level
Beltway
Ramp
Beltway
Hopper
N
1 Ft Up
6 Ft Up
Low End
4th Level Up
Spreaders
Top of Sinter at 2nd Level
SINTER
Paddle Wheel
5 Ft Up
Low End
2-S
2-N
Beltway
Ramp
Top at 3rd Level
Hopper
Side C

Figure A-12 - Detail, Plan Interior of Sinter Building, Indicating Locations 1 to 2S

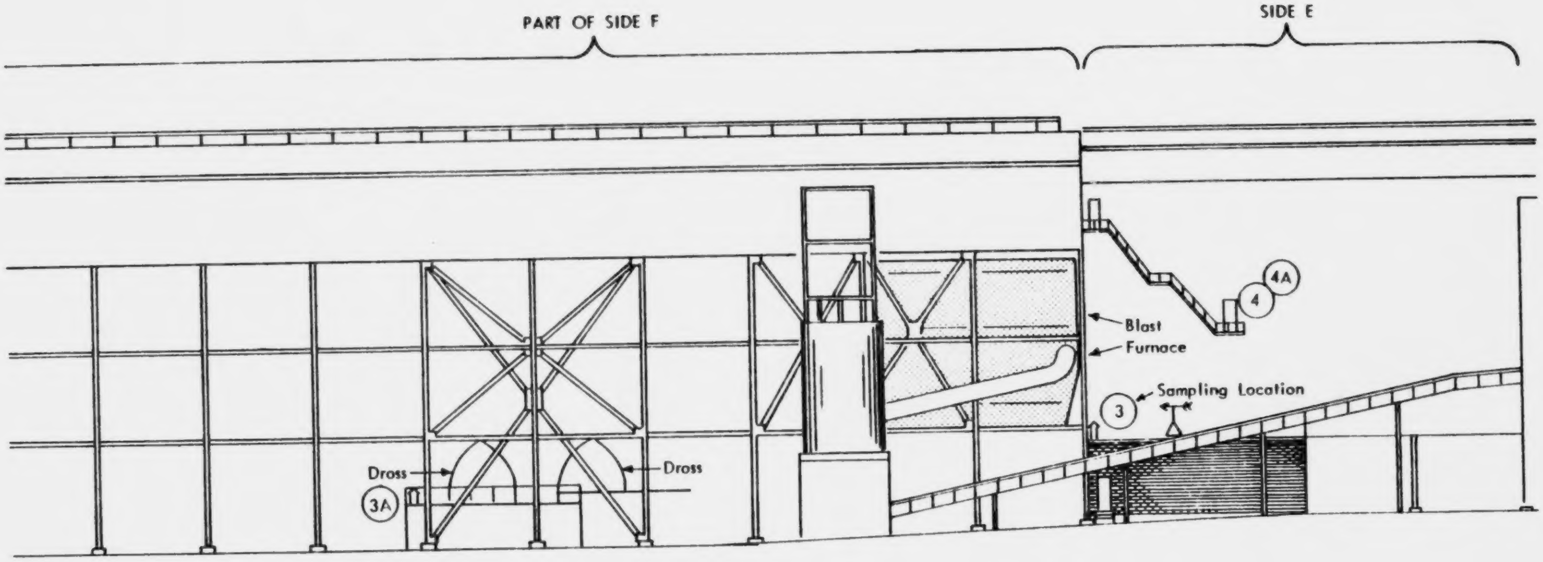

PART OF SIDE F
SIDE E
Blast
Furnace
4A
4
3
Sampling Location
Dross
3A
Dross

Figure A-13 - Detail, East Side of Dross-Kettle/Blast-Furnace Area, Indicating Locations 3 to 4A

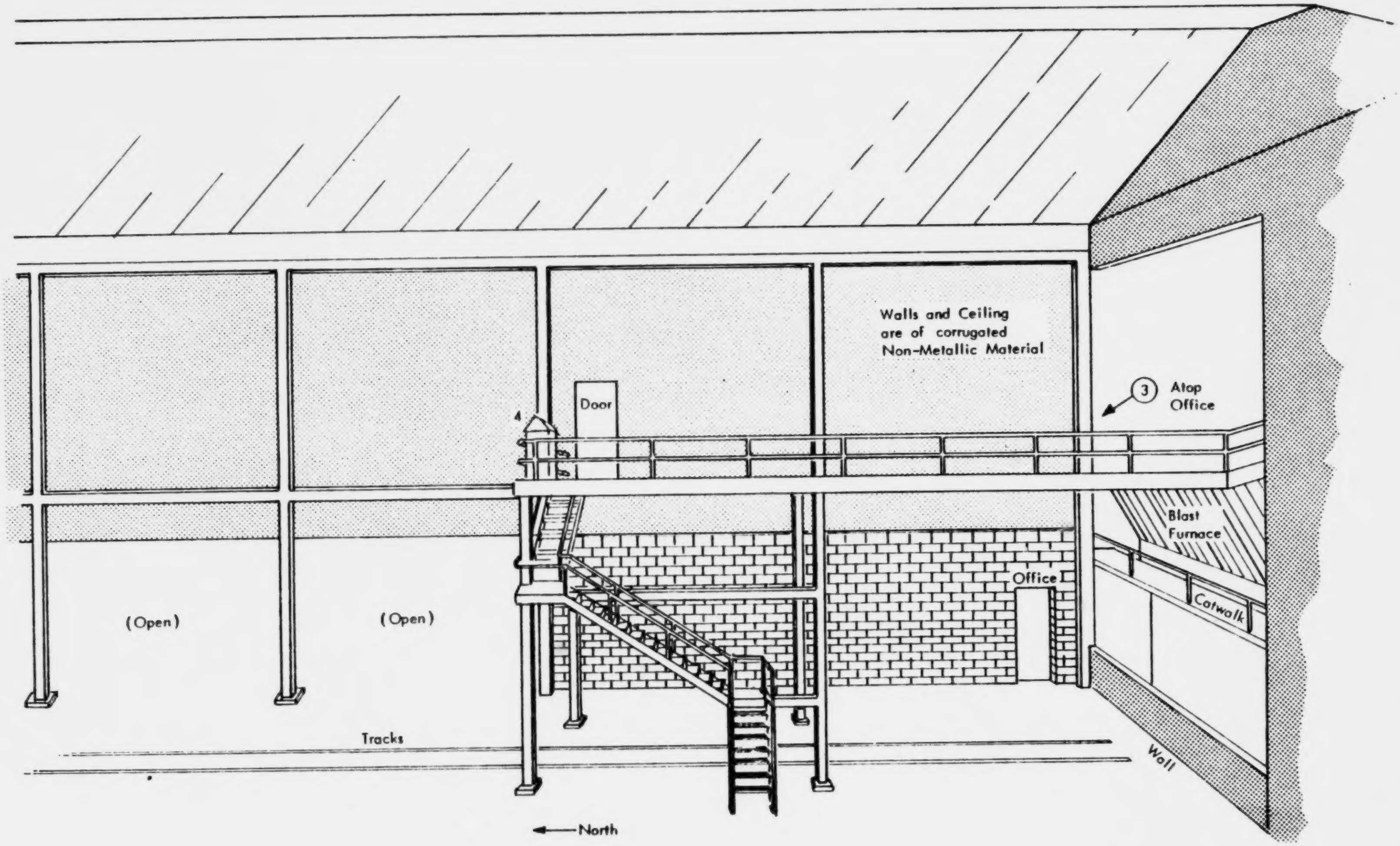

Walls and Ceiling
are of corrugated
Non-Metallic Material
③ Atop
Office
Door
4
Blast
Furnace
Office
Catwalk
(Open)
(Open)
Tracks
Wall
North

Figure A-14 - Detail, Blast-Furnace Area, Indicating Locations 3 and 4

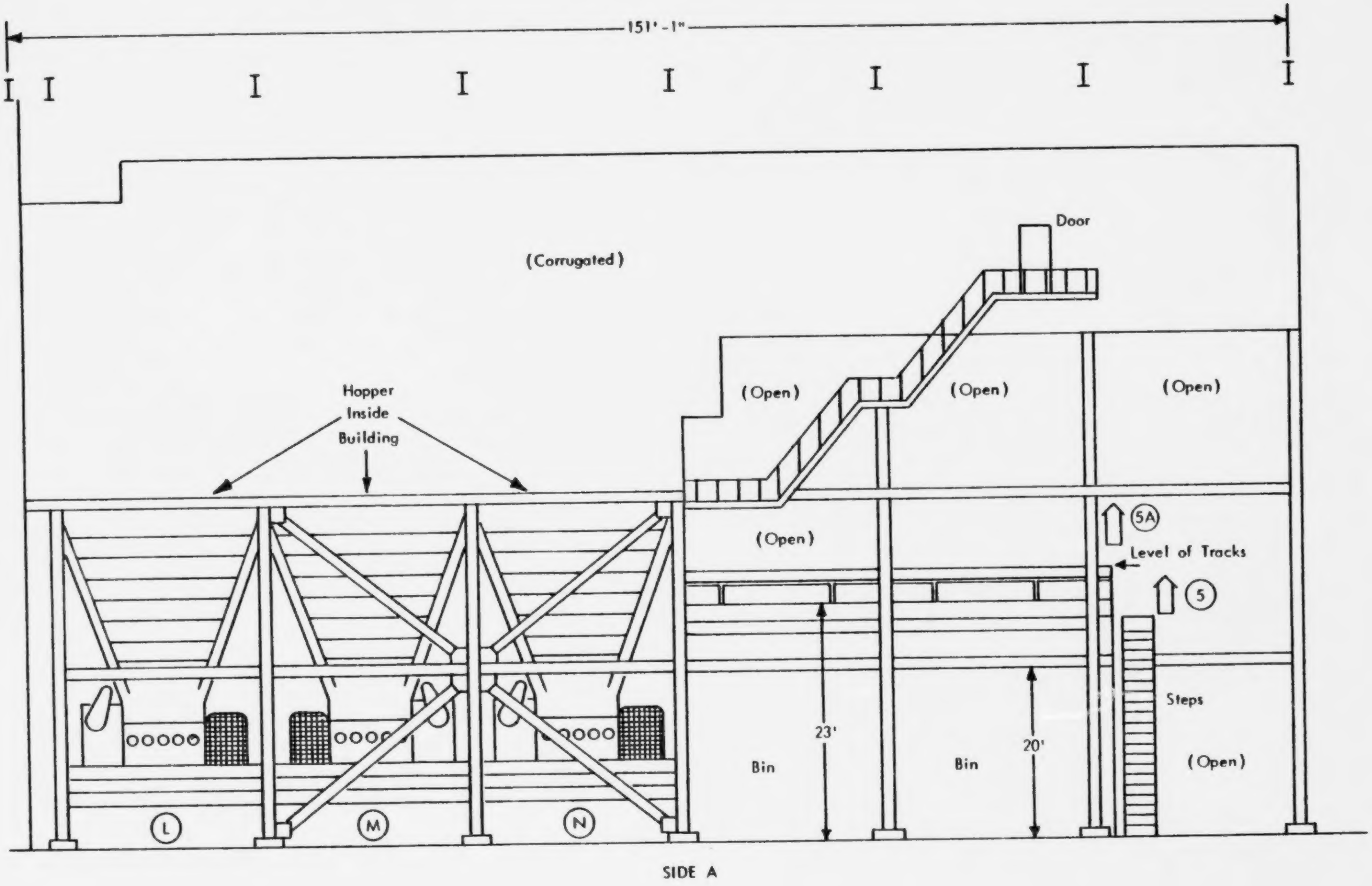

151'-1"
(Corrugated)
Door
Hopper
Inside
Building
(Open)
(Open)
(Open)
(Open)
5A
Level of Tracks
5
Steps
23'
20'
Bin
Bin
(Open)
L
M
N
SIDE A

Figure A-15 - Detail, Ore-Bin Area, Indicating Locations 5 and 5A

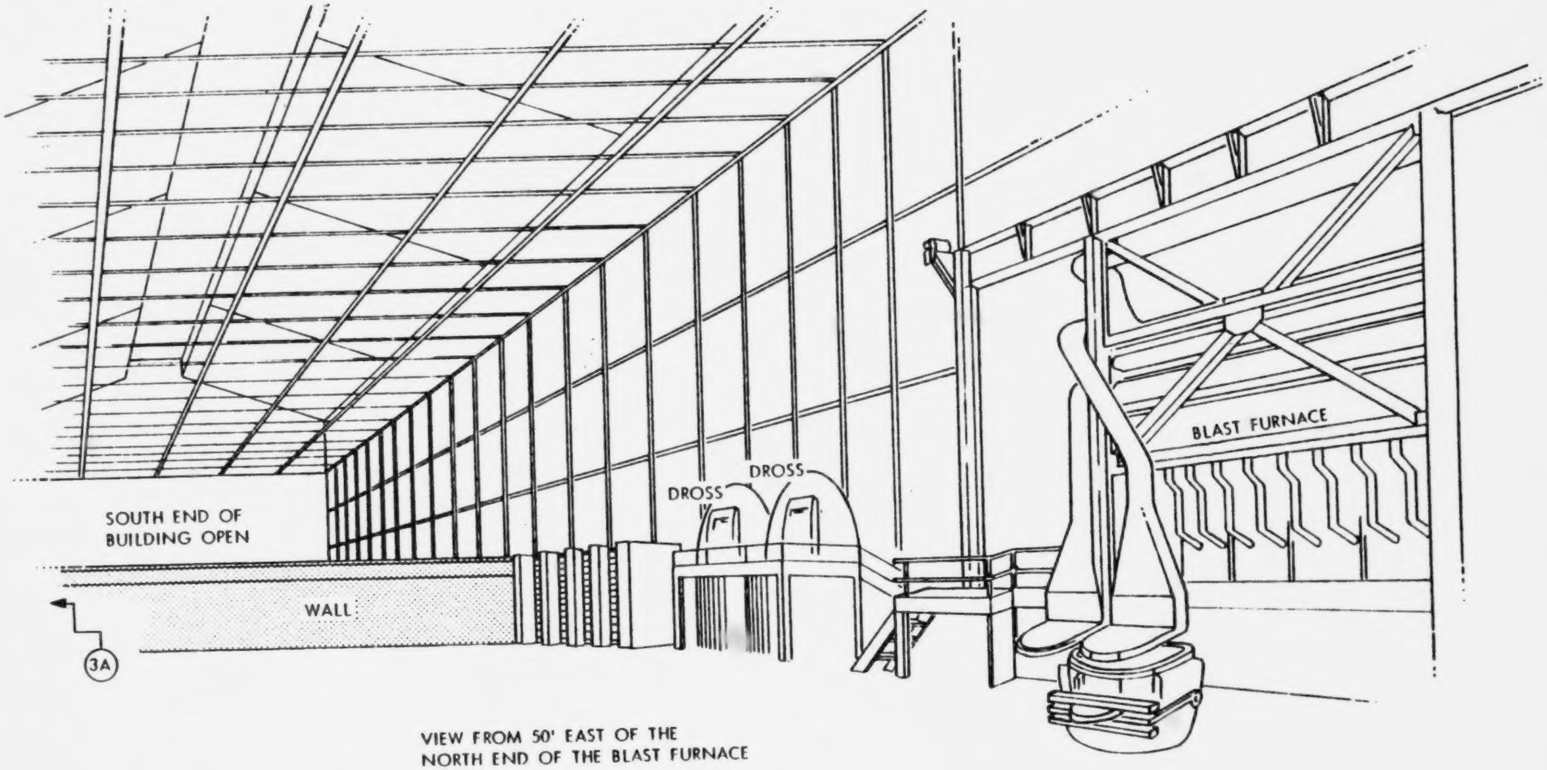

SOUTH END OF
BUILDING OPEN
WALL
3A
DROSS
DROSS
BLAST FURNACE
VIEW FROM 50' EAST OF THE
NORTH END OF THE BLAST FURNACE

Figure A-16 - View to the South Interior of Dross-Operations Building, Blast

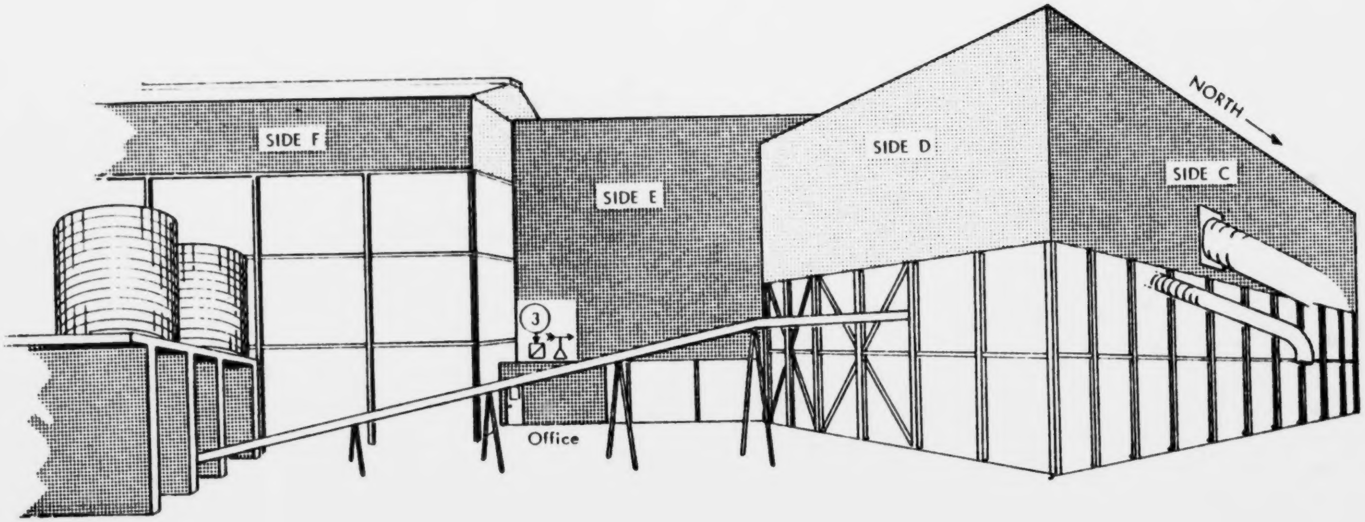

SIDE F
SIDE E
SIDE D
SIDE C
NORTH
3
Office

Figure A-17 - Detail, Back Side of Sinter Building (Side D) to Dross-Operations Building (Side F)

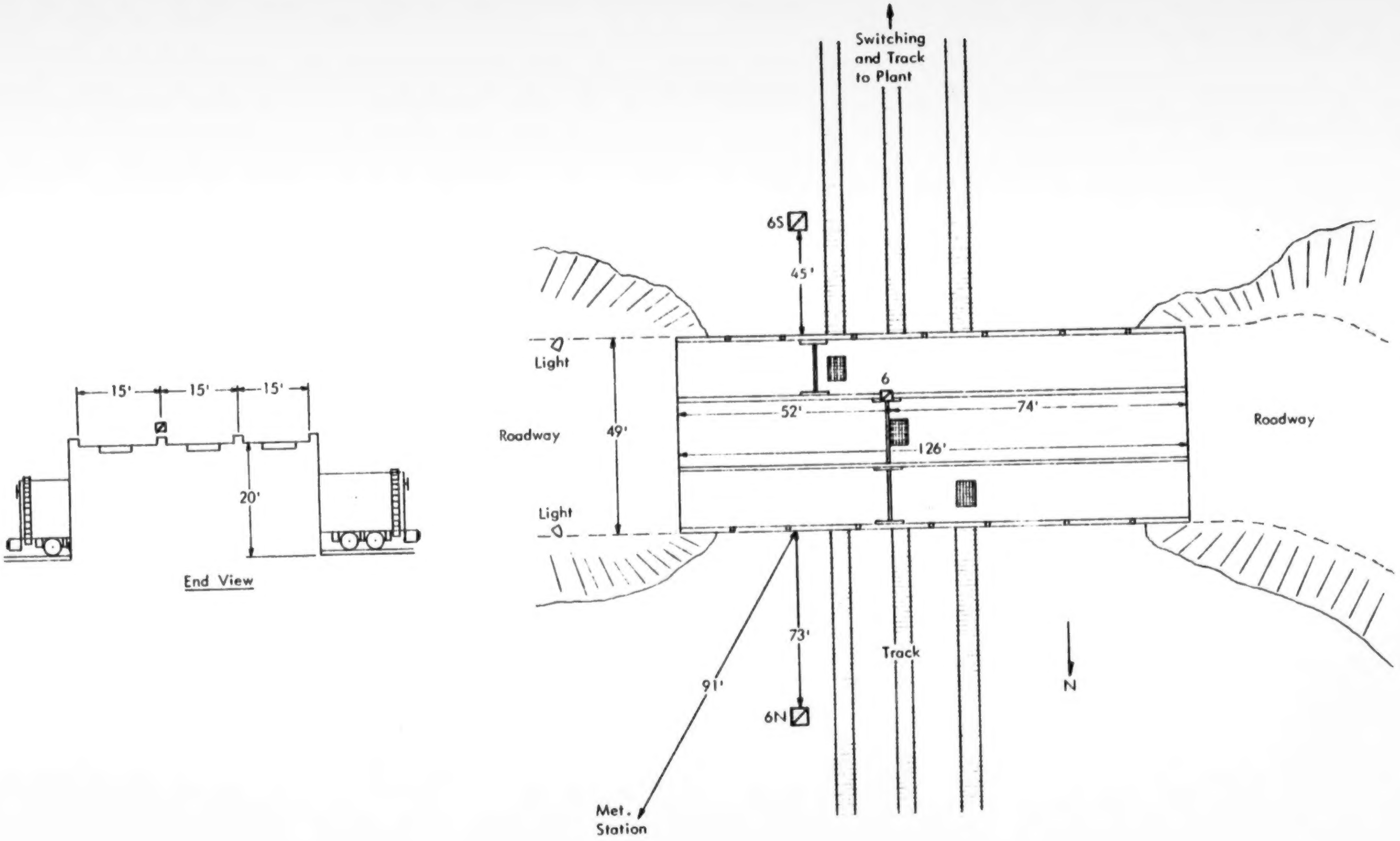

15'
15'
15'
20'
End View
Switching
and Track
to Plant
6S
45'
Light
Roadway
49'
Light
6
52'
74'
126'
Roadway
73'
91'
Track
N
6N
Met.
Station

Figure A-18 - Sampling Locations 6N, 6S, 6 Overpass, Overhead View

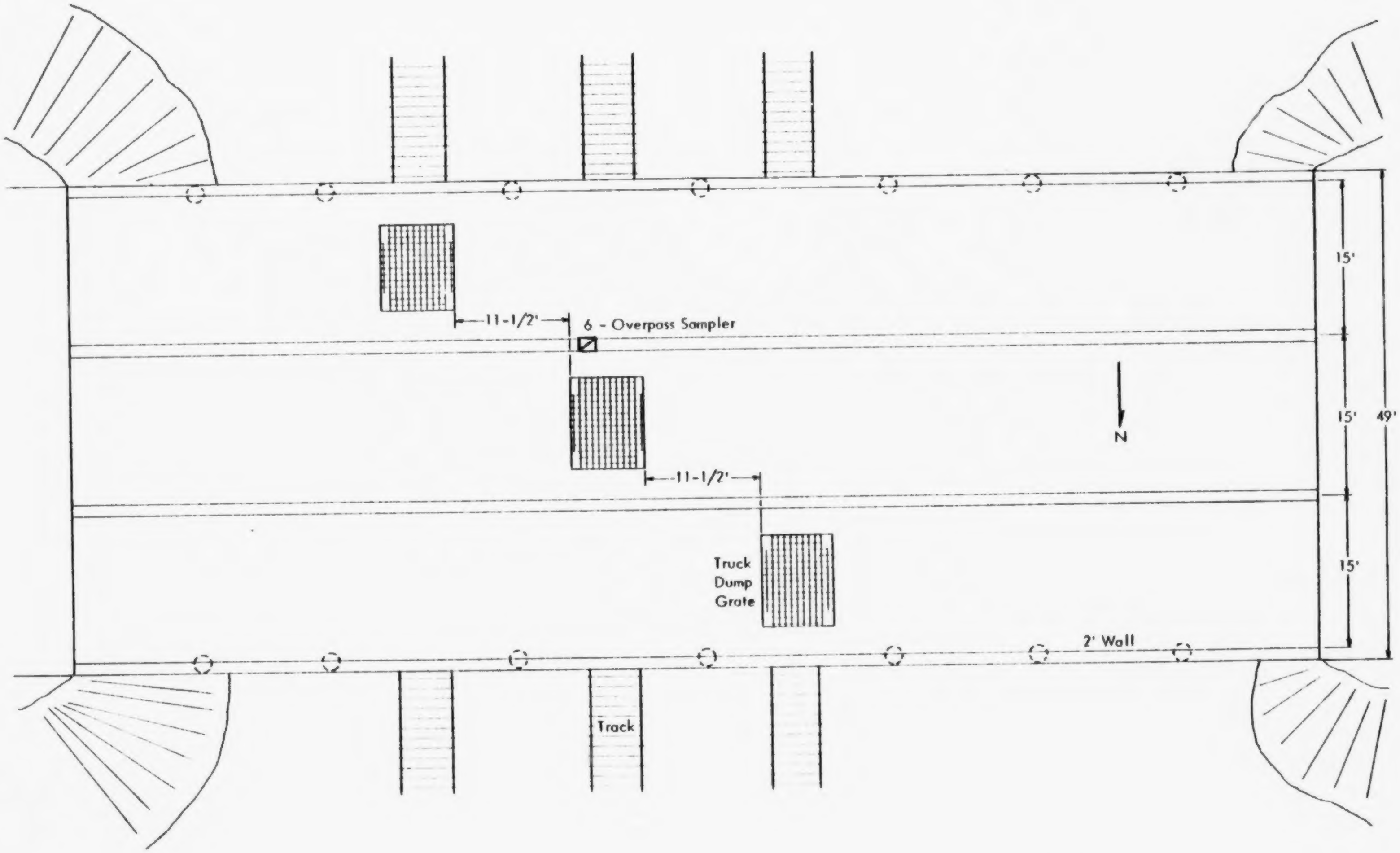

15'
15'
15'
49'
N
6 - Overpass Sampler
11-1/2'
11-1/2'
Truck
Dump
Grate
2' Wall
Track

Figure A-19 - Sampling Location 6, Detail

APPENDIX B

DRAWINGS OF THE ASARCO PLANT, EAST HELENA, MONTANA

(Sampling locations are identified)

DRAWINGS OF THE ASARCO PLANT, EAST HELENA, MONTANA

Sampling Locations		
No.	Point	Figure
11	Roof opening	B-1, B-3 to B-6
12	Vent duct	B-1 to B-6
13	Windows, top level east	B-1, B-2, B-6
14	Windows, middle level east	B-1, B-2, B-6
14A	Windows, middle level east	B-1, B-2, B-6
15	North windows, sinter level	B-1 to B-3, B-5, B-6
16	South windows, sinter level	B-1 to B-4, B-6
17	Dross operations	B-1, B-8 to B-11
18	Reverberatory furnace	B-1, B-7, B-9 to B-11
19	Blast-furnace roof opening	B-1, B-12, B-13, B-15
20	Blast-furnace vent duct	B-1, B-12, B-14, B-15
21	Rail loading, zinc fuming	B-1, B-16 to B-18
22	Tunnel, zinc fuming	B-1, B-18
23	Zinc-furnace, roof opening	B-1, B-19, B-20, B-22
23A	Ground level vicinity zinc furnace	B-1, B-19 to B-22
24N	Ore loading - north	B-1
24S	Ore loading - south	B-1

Figure Title Page

B-1 General Plant Plan View, Indicating Locations 11 to 24S . B-4

B-2 Detail, Northeast Side of Sinter Building, Indicating Locations 12 to 16. . . . . B-5

B-3 Detail, Southwest Side of Sinter Building, Indicating Locations 11, 12, 15, and 16. . . . . B-6

B-4 Detail, Southeast Side of Sinter Building, Indicating Locations 11, 12, and 16. . . . . B-7

B-5 Detail, Northwest Side of Sinter Building, Indicating Locations 11, 12, and 15. . . . . B-8

B-6 Detail, Roof of Sinter Building, Indicating Locations 11 to 16. . . . . B-9

Figure	Title	Page
B-7	Detail, Southwest Side of Dross-Reverberatory Building, Indicating Location 18.	B-10
B-8	Detail, Northeast Side of Dross-Reverberatory Building, Indicating Location 17.	B-11
B-9	Detail, Northwest Side of Dross-Reverberatory Building, Indicating Locations 17 and 18.	B-12
B-10	Detail, Southeast Side of Dross-Reverberatory Building, Indicating Locations 17 and 18.	B-13
B-11	Detail, Roof of Dross-Reverberatory Building, Indicating Locations 17 and 18.	B-14
B-12	Detail, Southeast Side of Blast-Furnace Building, Indicating Locations 19 and 20.	B-15
B-13	Detail, Southwest Side of Blast-Furnace Building, Indicating Location 19.	B-16
B-14	Detail, Northeast Side of Blast-Furnace Building, Indicating Location 20.	B-17
B-15	Detail, Roof of Blast-Furnace Building, Indicating Locations 19 and 20	B-18
B-16	Perspective View of Zinc-Fume Rail Loading, Indicating Location 21	B-19
B-17	Detail, Northeast Side of Zinc-Fume Building, Indicating Location 21	B-20
B-18	Detail, Northwest Side of Zinc-Fume Building, Indicating Locations 21 and 22	B-21
B-19	Detail, Northeast Side of Zinc-Furnace Building, Indicating Locations 23 and 23A	B-22
B-20	Detail, Southeast Side of Zinc-Furnace Building, Indicating Locations 23 and 23A	B-23
B-21	Detail, Southwest Side of Zinc-Furnace Building, Indicating Location 23A	B-24
B-22	Detail, Roof of Zinc-Furnace Building, Indicating Locations 23 and 23A.	B-25

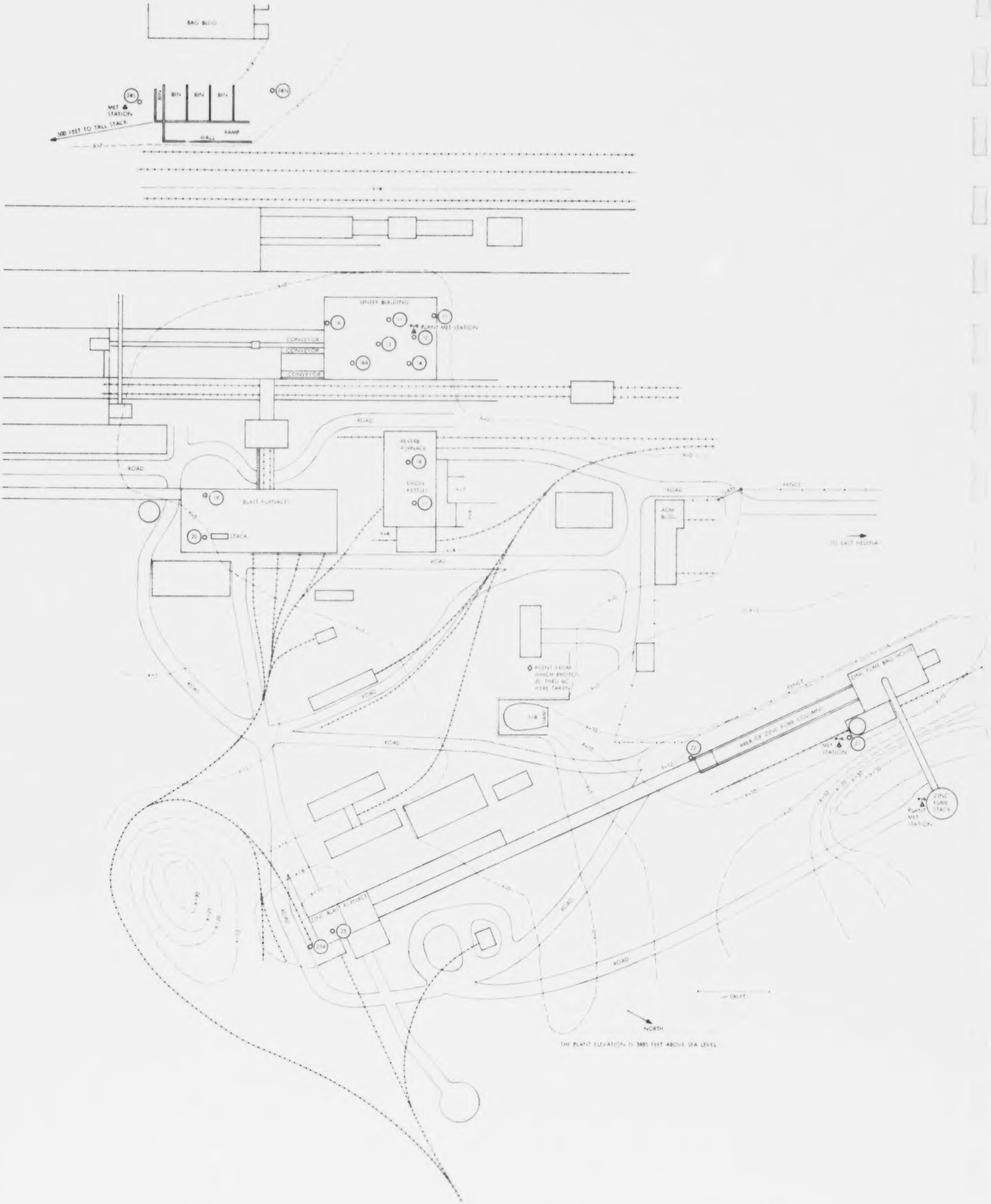
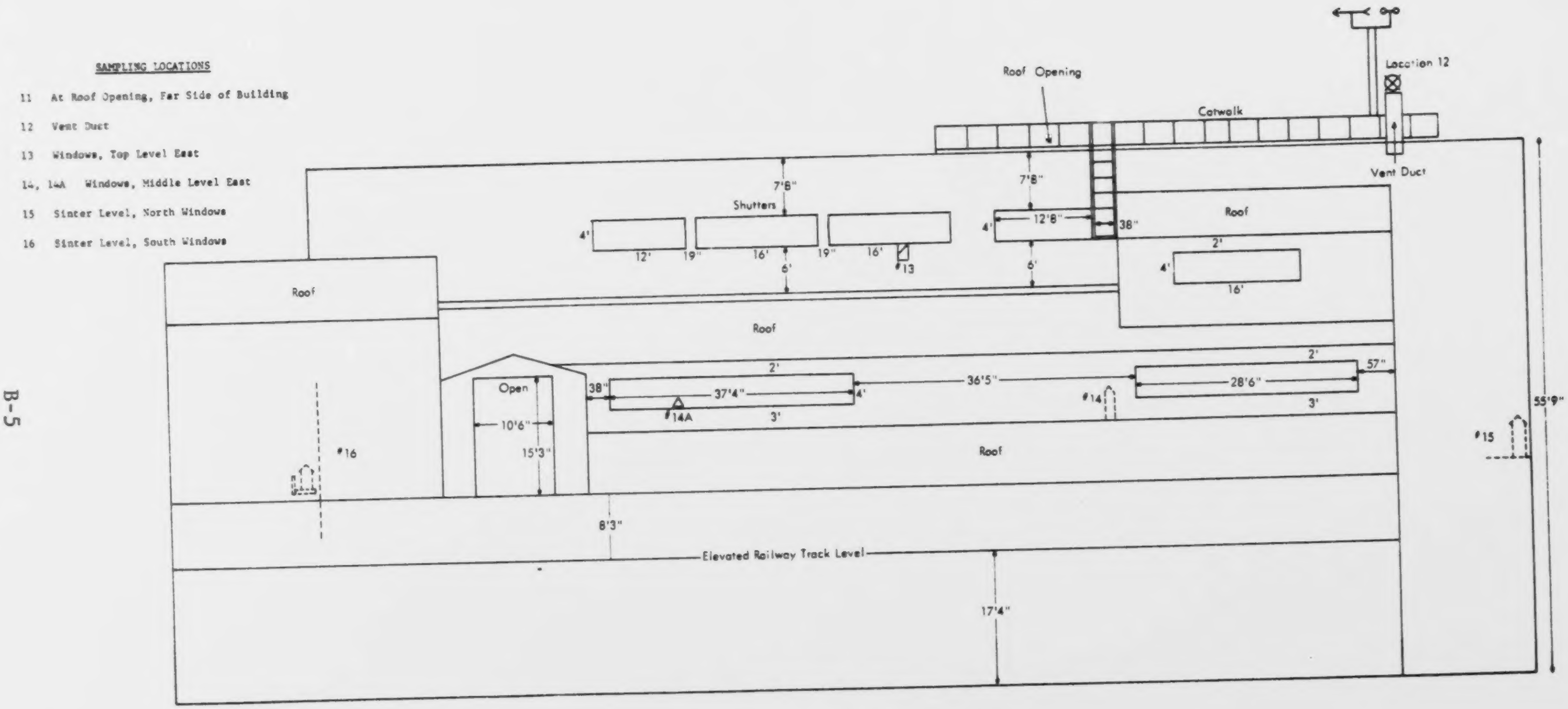

BAG BLDG
BIN
BIN
BIN
BIN
24S
24N
MET STATION
500 FEET TO TALL STACK
WALL
RAMP
SINTER BUILDING
6
11
11
12
13
14A
14
PLANT MET STATION
CONVEYOR
CONVEYOR
CONVEYOR
ROAD
REVERB FURNACE
18
DROSS KETTLES
17
19
BLAST FURNACES
20
STACK
ROAD
ROAD
FENCE
ADM BLDG
TO EAST HELENA
POINT FROM WHICH PHOTOS 2C THRU 6C WERE TAKEN
DAM
ROAD
ROAD
FENCE
ZINC FUME BAG HOUSE
AREA OF ZINC FUME COLUMNS
22
21
MET STATION
ZINC FUME STACK
PLANT MET STATION
ZINC BLAST FURNACE
23
23A
ROAD
ROAD
ROAD
100 FT
NORTH
THE PLANT ELEVATION IS 3885 FEET ABOVE SEA LEVEL

Figure B-1 - General Plant Plan View, Indicating Locations 11 to 24S


Roof Opening
Catwalk
Location 12
Vent Duct
Roof
Shutters
7'8"
7'8"
12'8"
38"
4'
12'
19"
16'
19"
16'
#13
6'
6'
2'
4'
16'
Roof
Roof
Roof
Open
10'6"
15'3"
38"
2'
37'4"
4'
#14A
3'
36'5"
#14
2'
28'6"
57"
3'
Roof
#15
55'9"
#16
8'3"
Elevated Railway Track Level
17'4"

SAMPLING LOCATIONS

11 At Roof Opening, Far Side of Building
12 Vent Duct
13 Windows, Top Level East
14, 14A Windows, Middle Level East
15 Sinter Level, North Windows
16 Sinter Level, South Windows

Figure B-2 - Detail, Northeast Side of Sinter Building, Indicating Locations 12 to 16

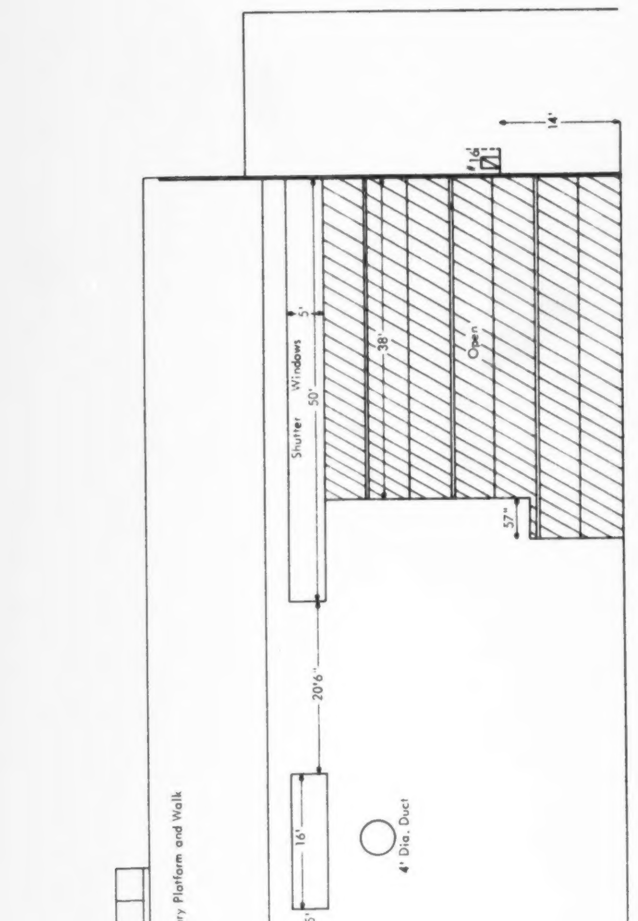
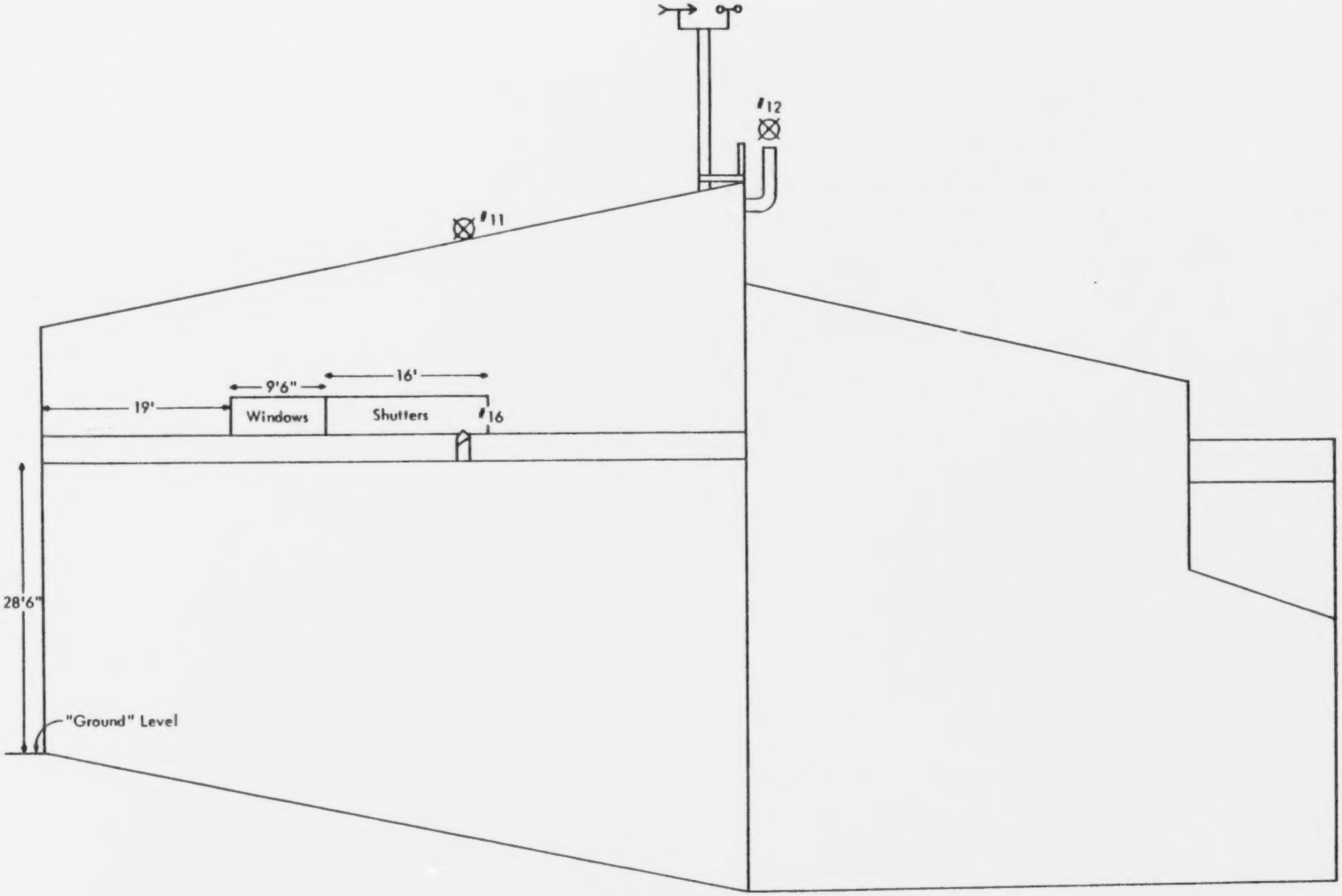

Catwalk
Location 11
Temporary Platform and Walk
Roof Opening
Location 12
Vent Duct
Roof
Shutter Windows
50'
5'
38'
Open
57"
#16
14'
20'6"
16'
5'
4' Dia. Duct
11'
10'6"
28'
#15
55'9"
42'

Figure B-3 - Detail, Southwest Side of Sinter Building, Indicating Locations 11, 12, 15, and 16



#12
#11
9'6"
16'
19'
Windows
Shutters
#16
28'6"
"Ground" Level

Figure B-4 - Detail, Southeast Side of Sinter Building, Indicating Locations 11, 12, and 16

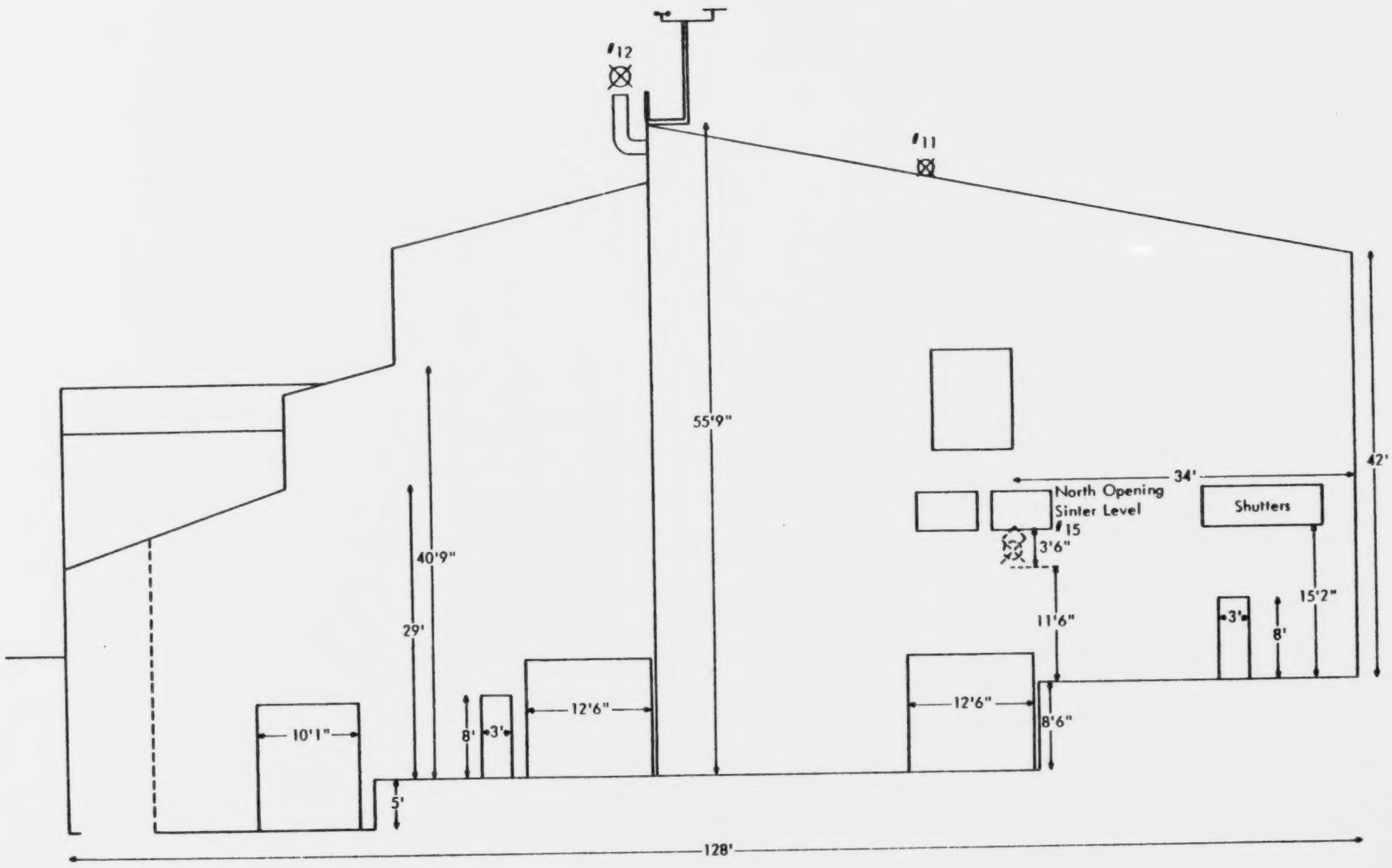
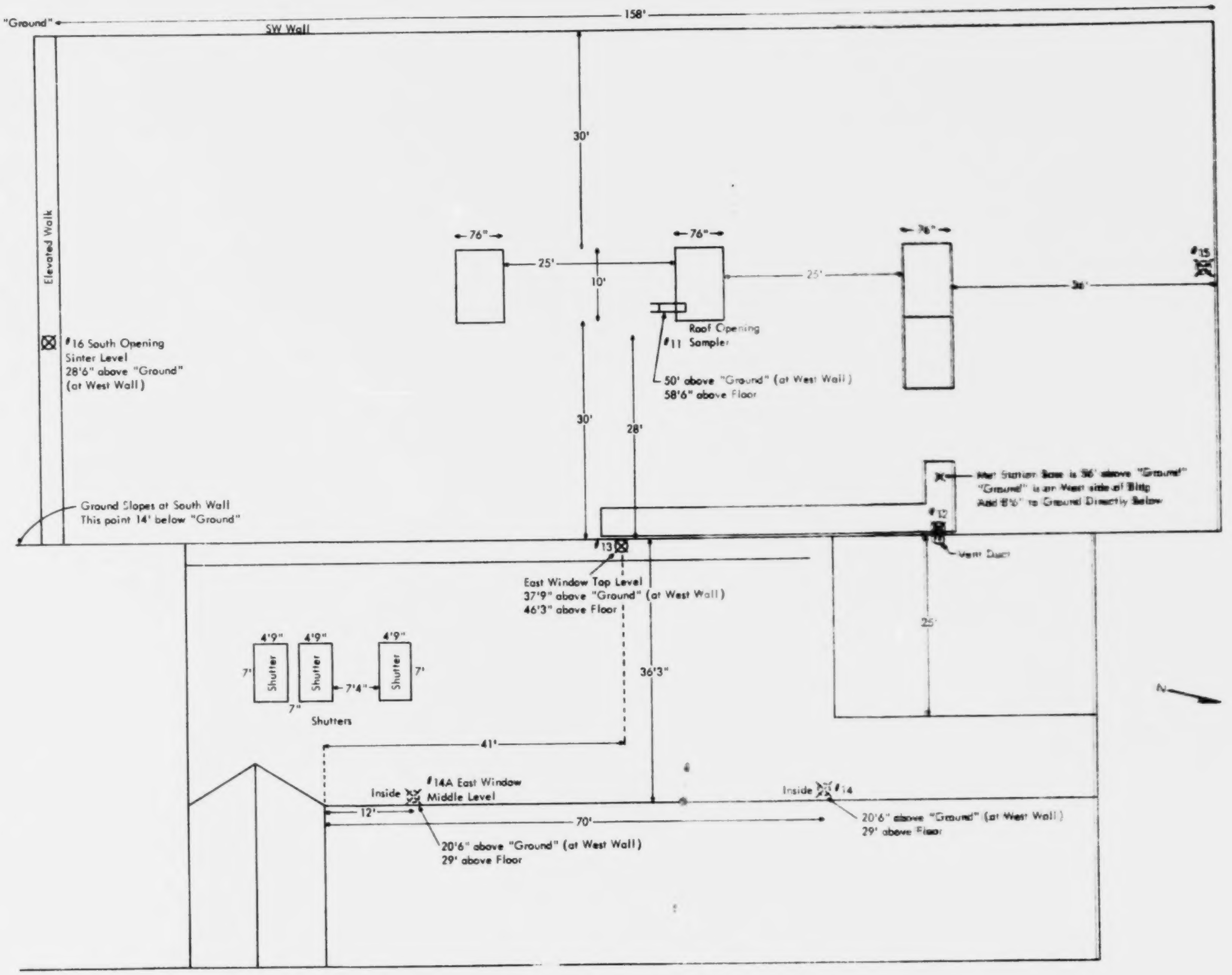

#12
#11
55'9"
42'
34'
North Opening
Sinter Level
#15
Shutters
3'6"
11'6"
15'2"
3'
8'
12'6"
8'6"
40'9"
29'
8'
3'
12'6"
10'1"
5'
128'

Figure B-5 - Detail, Northwest Side of Sinter Building, Indicating Locations 11, 12, and 15



"Ground"
158'
SW Wall
Elevated Walk
#16 South Opening
Sinter Level
28'6" above "Ground"
(at West Wall)
Ground Slopes at South Wall
This point 14' below "Ground"
30'
76"
25'
10'
76"
Roof Opening
#11 Sampler
50' above "Ground" (at West Wall)
58'6" above Floor
25'
76"
36'
#15
30'
28'
Met Station Base is 56' above "Ground"
"Ground" is on West side of Bldg
Add 8'6" to Ground Directly Below
#12
Vent Duct
25'
#13
East Window Top Level
37'9" above "Ground" (at West Wall)
46'3" above Floor
36'3"
4'9"
4'9"
4'9"
7'
Shutter
Shutter
7'4"
Shutter
7'
7"
Shutters
41'
Inside
#14A East Window
Middle Level
12'
70'
20'6" above "Ground" (at West Wall)
29' above Floor
Inside
#14
20'6" above "Ground" (at West Wall)
29' above Floor
N

Figure B-6 - Detail, Roof of Sinter Building, Indicating Locations 11 to 16

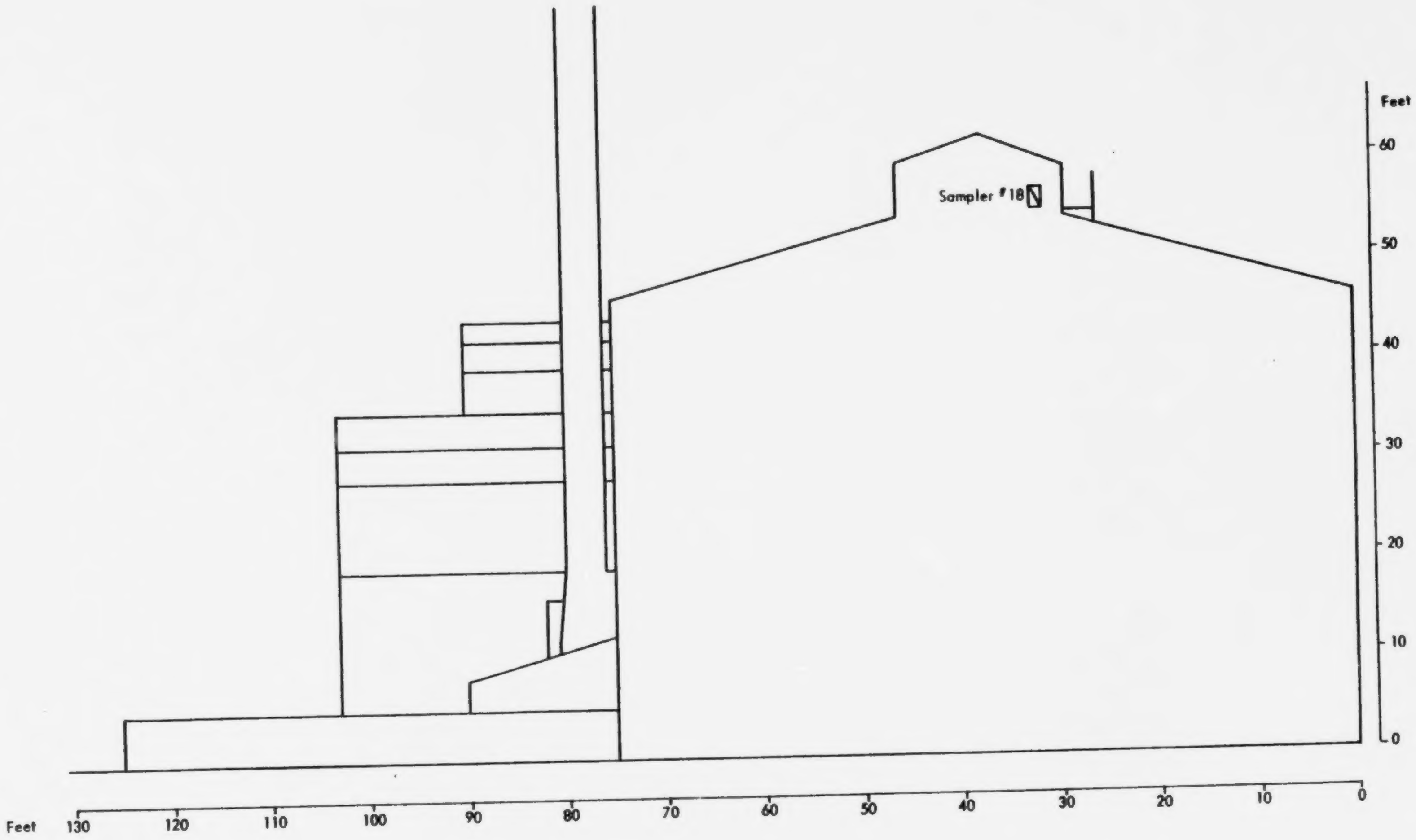

Feet
60
50
40
30
20
10
0
Sampler #18
Feet
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Figure B-7 - Detail, Southwest Side of Dross-Reverberatory Building, Indicating Location 18

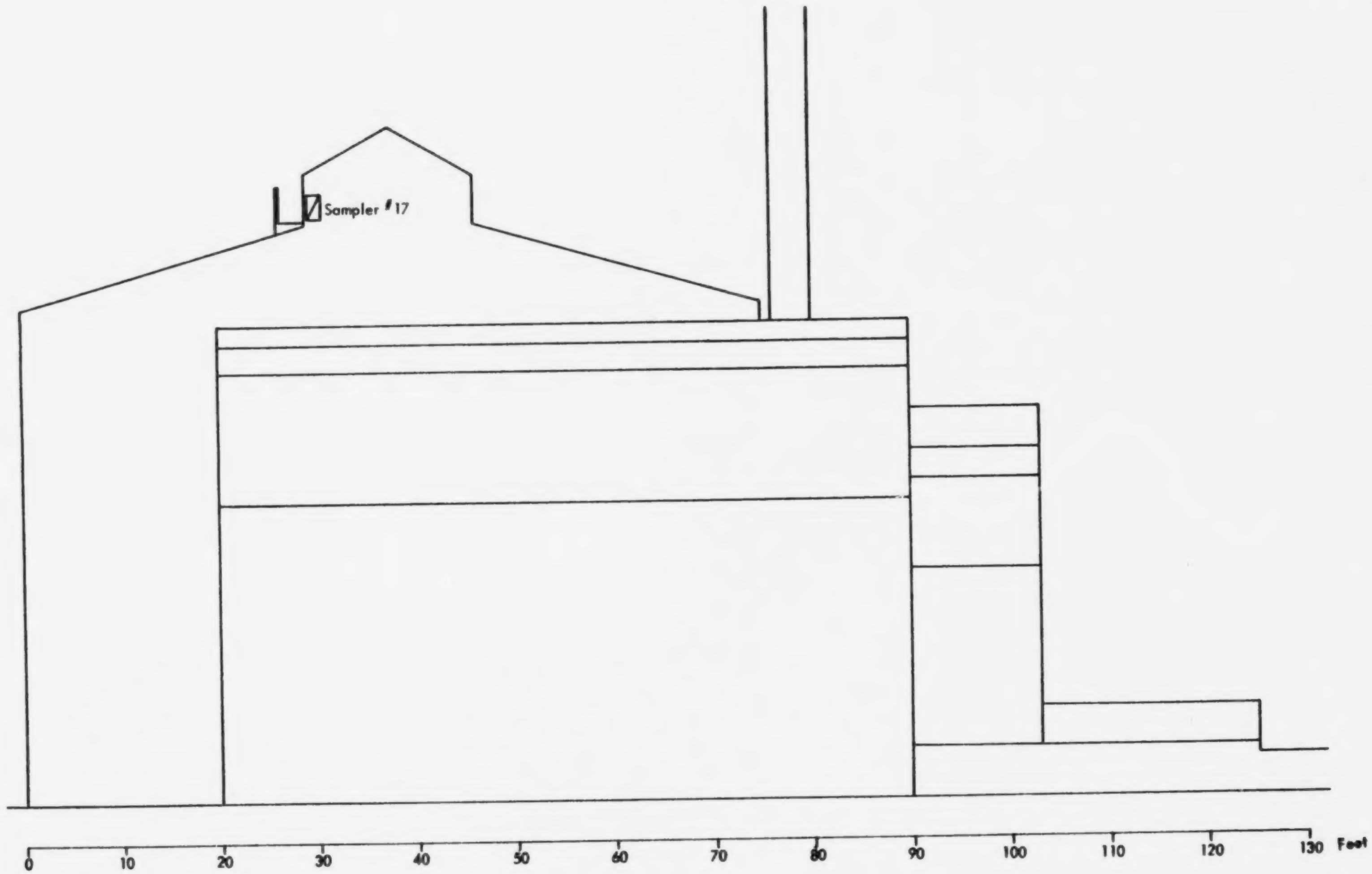
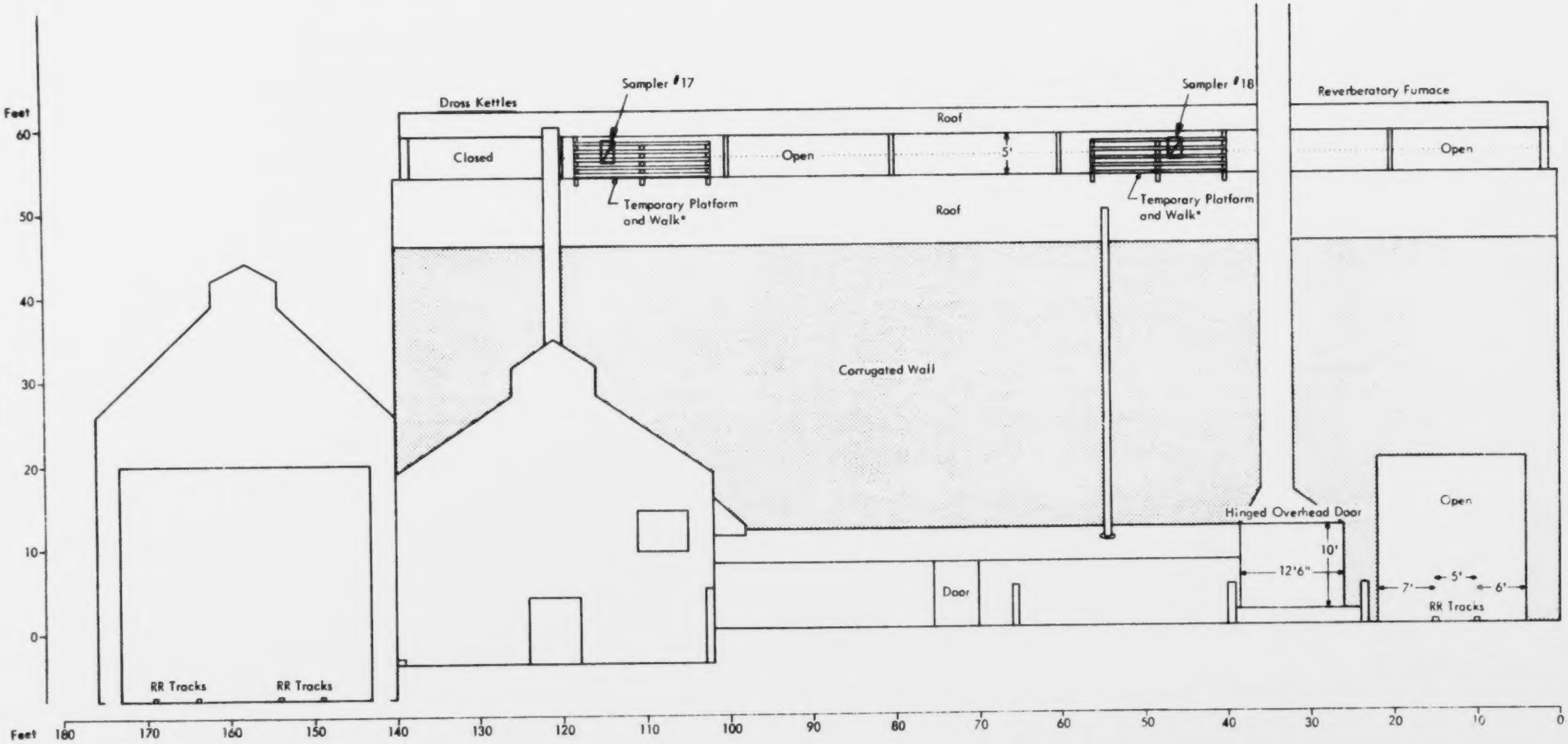
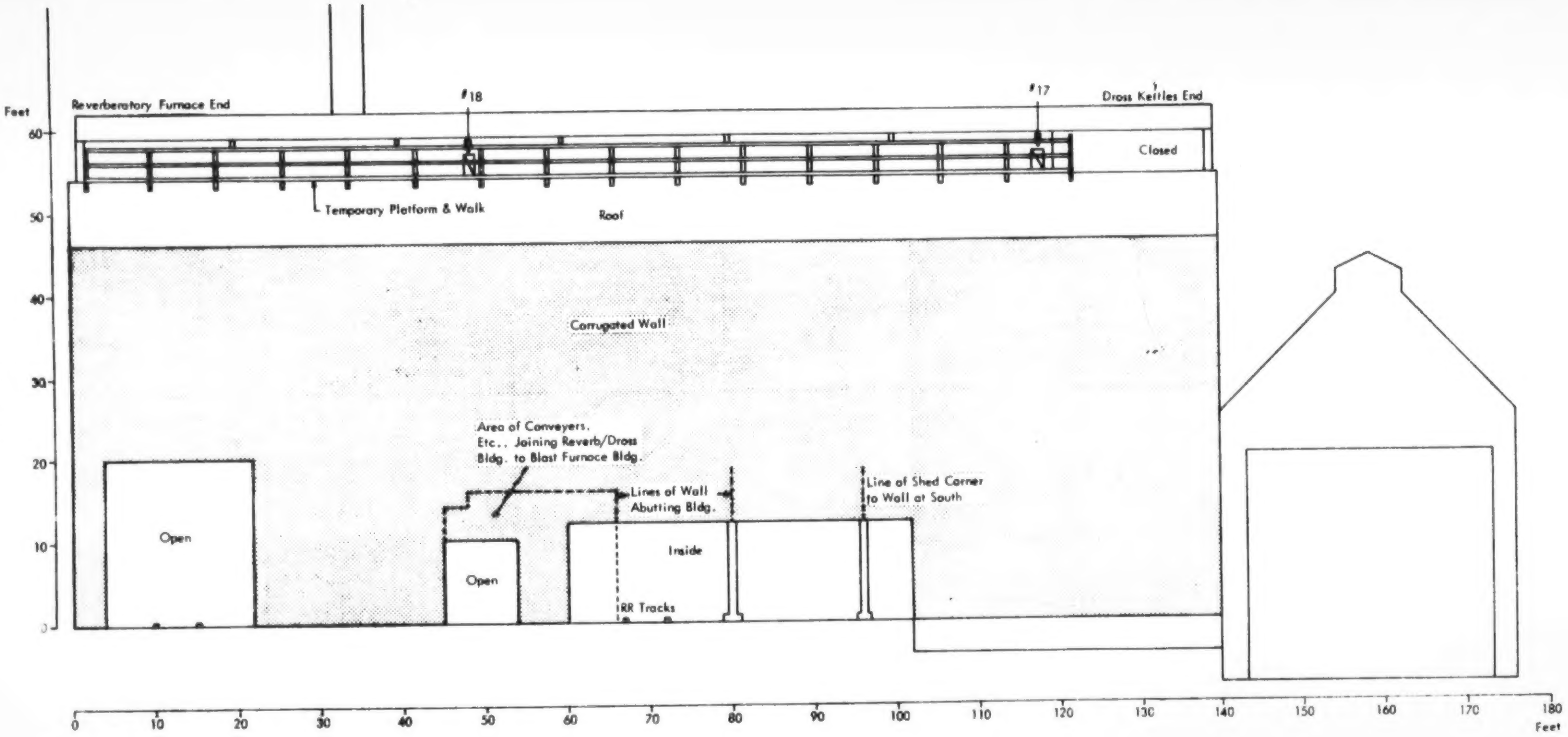

Sampler #17
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Feet

Figure B-8 - Detail, Northeast Side of Dross-Reverberatory Building, Indicating Location 17


Feet
60
50
40
30
20
10
0
Dross Kettles
Sampler #17
Sampler #18
Reverberatory Furnace
Roof
Closed
Open
5'
Open
Temporary Platform and Walk*
Temporary Platform and Walk*
Roof
Corrugated Wall
Open
Hinged Overhead Door
10'
12'6"
7'
5'
6'
RR Tracks
Door
RR Tracks
RR Tracks
Feet
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

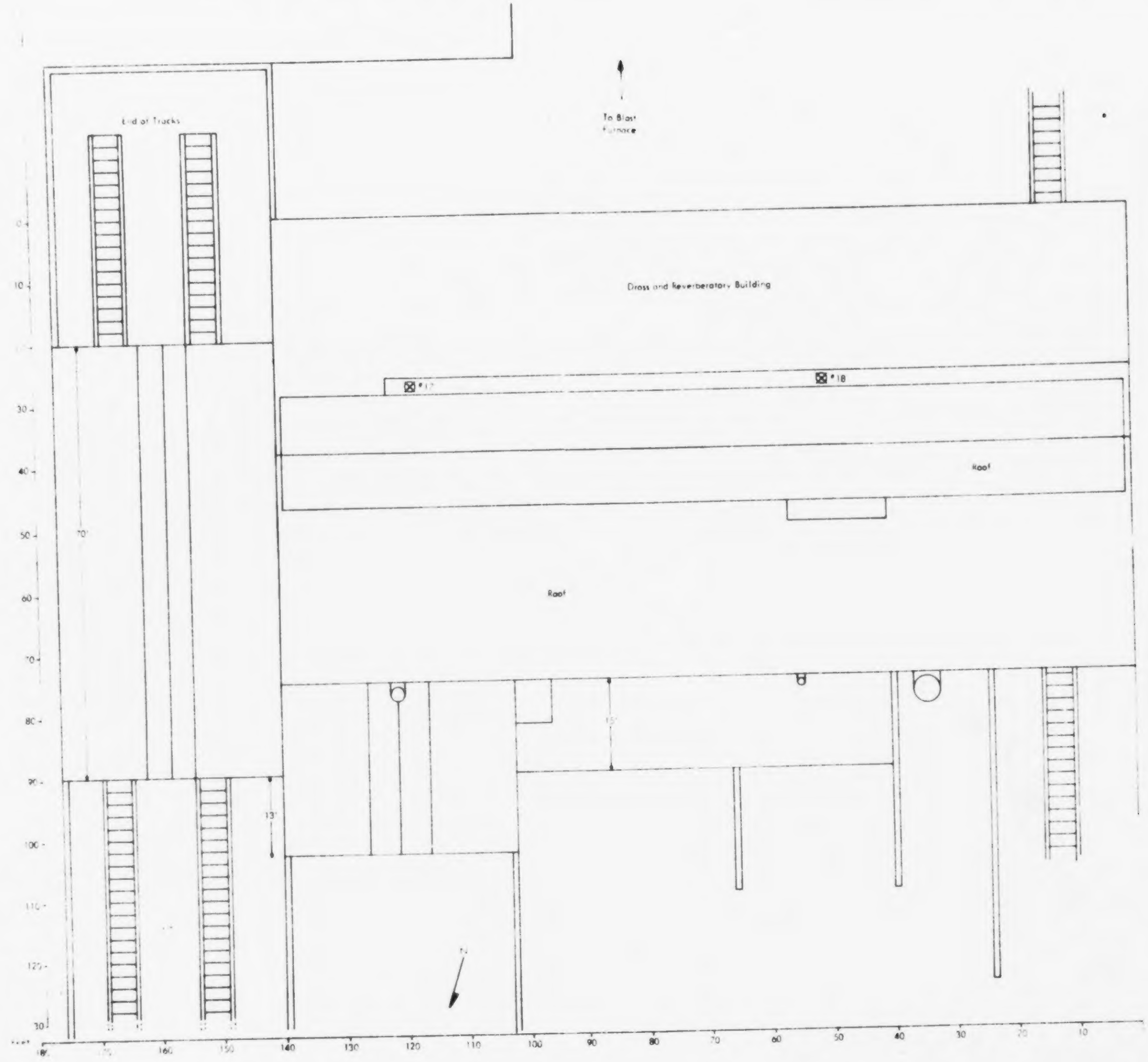
*See Modifications Write-up in Section I

Figure B-9 - Dross and Reverberatory Building, View to the South



Feet
60
50
40
30
20
10
0
Reverberatory Furnace End
#18
#17
Dross Kettles End
Closed
Temporary Platform & Walk
Roof
Corrugated Wall
Area of Conveyers,
Etc., Joining Reverb/Dross
Bldg. to Blast Furnace Bldg.
Lines of Wall
Abutting Bldg.
Line of Shed Corner
to Wall at South
Open
Open
Inside
RR Tracks
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Feet

Figure B-10 - Dross and Reverberatory Building,
View to the North



End of Tracks
To Blast Furnace
Dross and Reverberatory Building
#17
#18
Roof
Roof
70'
13'
15'
N
feet
0
10
30
40
50
60
70
80
90
100
110
120
130
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

Figure B-11 - Detail, Roof of Dross-Reverberatory Building, Indicating Locations 17 and 18

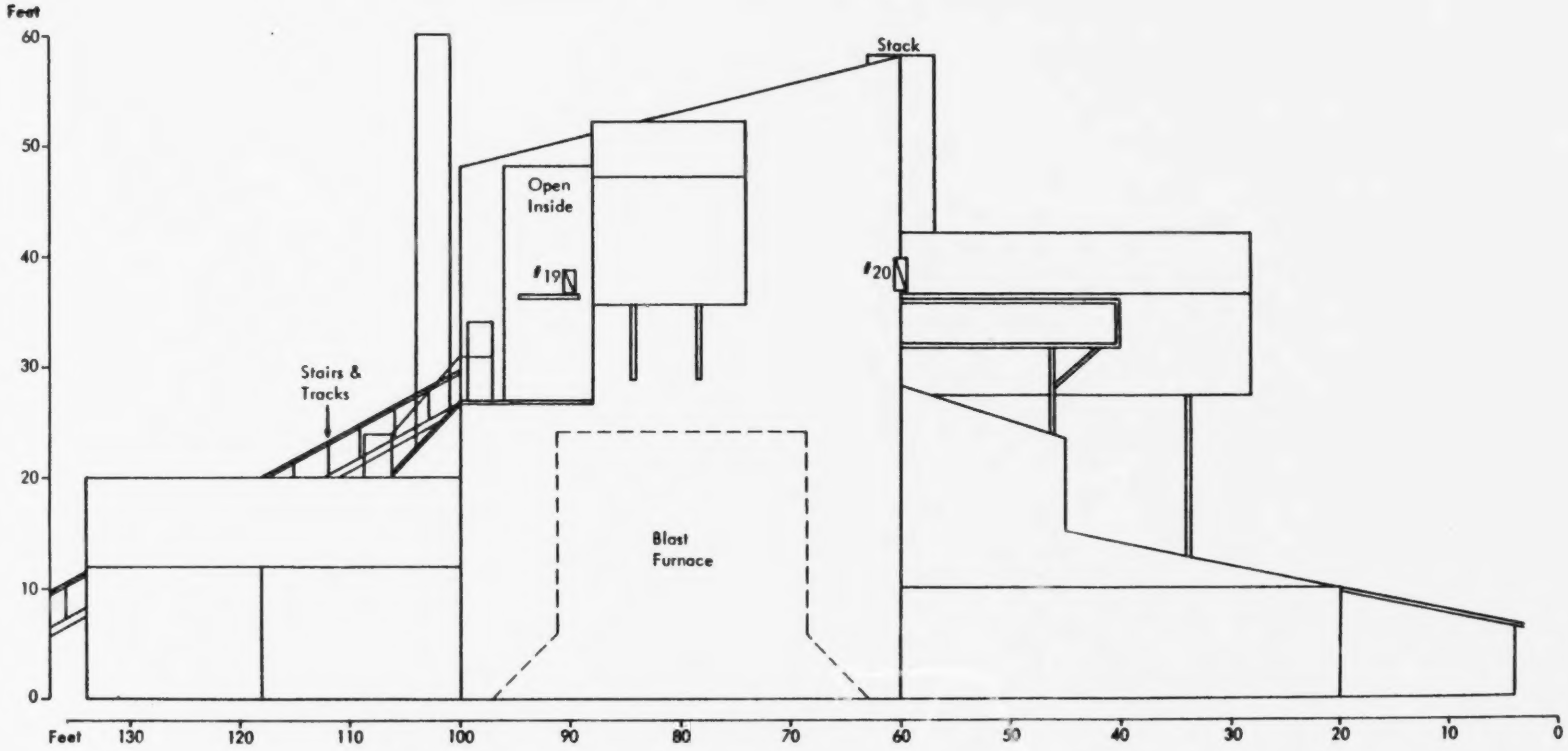

Feet
60
50
40
30
20
10
0
Stairs &
Tracks
Open
Inside
#19
Stack
#20
Blast
Furnace
Feet
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Figure B-12 - Detail, Southeast Side of Blast-Furnace Building, Indicating Locations 19 and 20

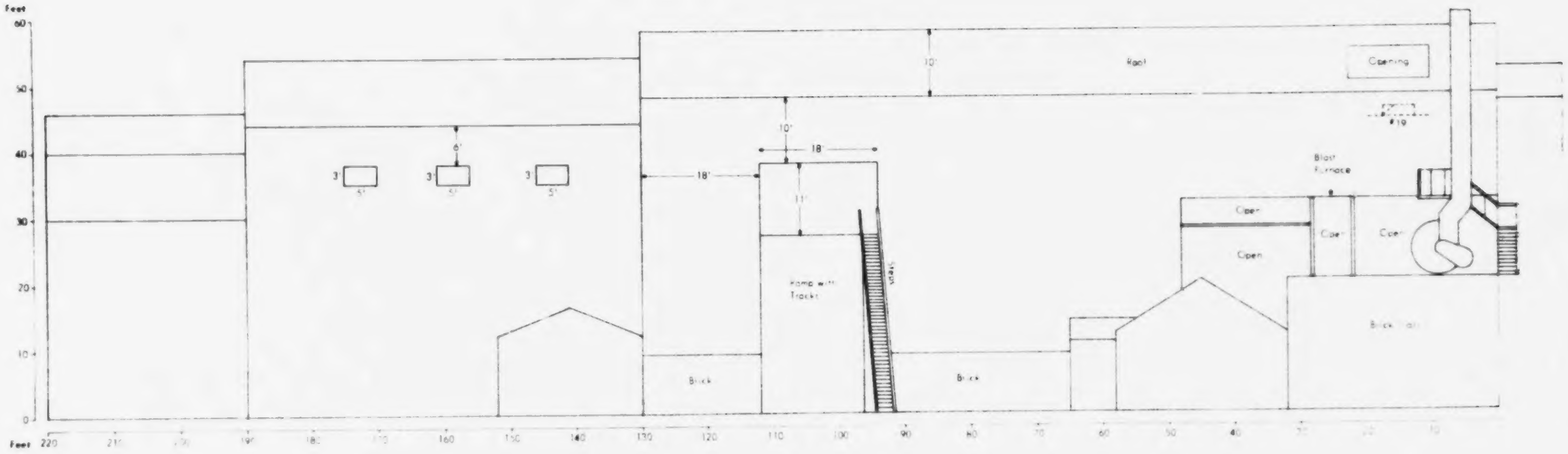

Feet
60
50
40
30
20
10
0
Feet
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Roof
Opening
10'
#19
Blast
Furnace
Open
Open
Open
Open
Brick Wall
10'
18'
18'
11'
6'
3'
5'
3'
5'
3'
5'
Ramp with
Tracks
Steps
Brick
Brick

Figure B-13 - Detail, Southwest Side of Blast-Furnace Building, Indicating Location 19

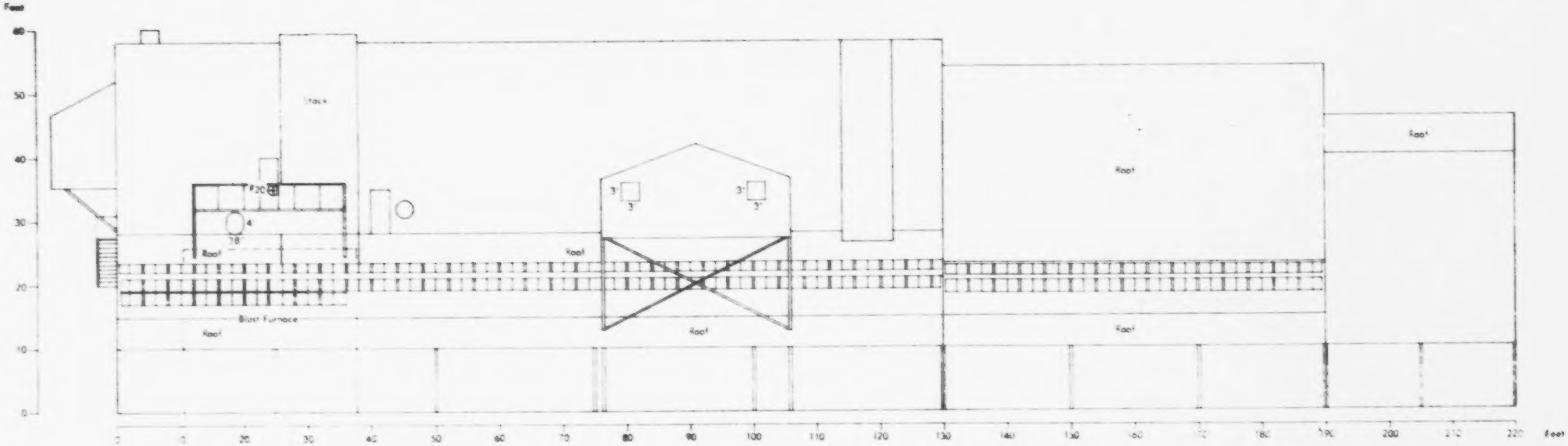

Feet
60
50
40
30
20
10
0
Stack
#20
4
18
Roof
Roof
Blast Furnace
Roof
3'
3'
3'
3'
Roof
Roof
Roof
Roof
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
Feet

Figure B-14 - Detail, Northeast Side of Blast-Furnace Building, Indicating Location 20

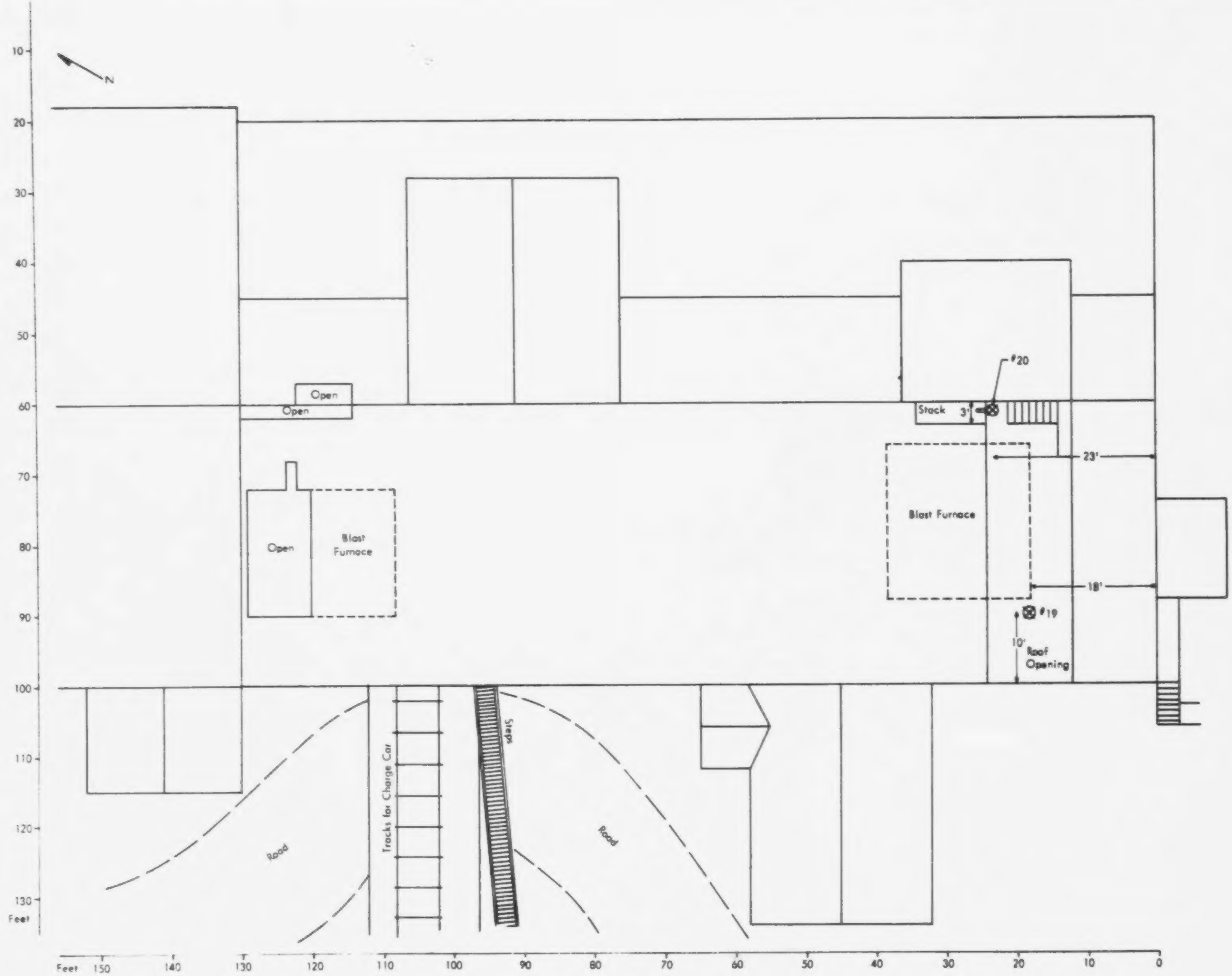

N
Open
Open
Open
Blast Furnace
Stack
3'
#20
23'
Blast Furnace
18'
#19
10'
Roof Opening
Tracks for Charge Car
Steps
Road
Road
10
20
30
40
50
60
70
80
90
100
110
120
130
Feet
Feet
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Figure B-15 - Detail, Roof of Blast-Furnace Building, Indicating Locations 19 and 20

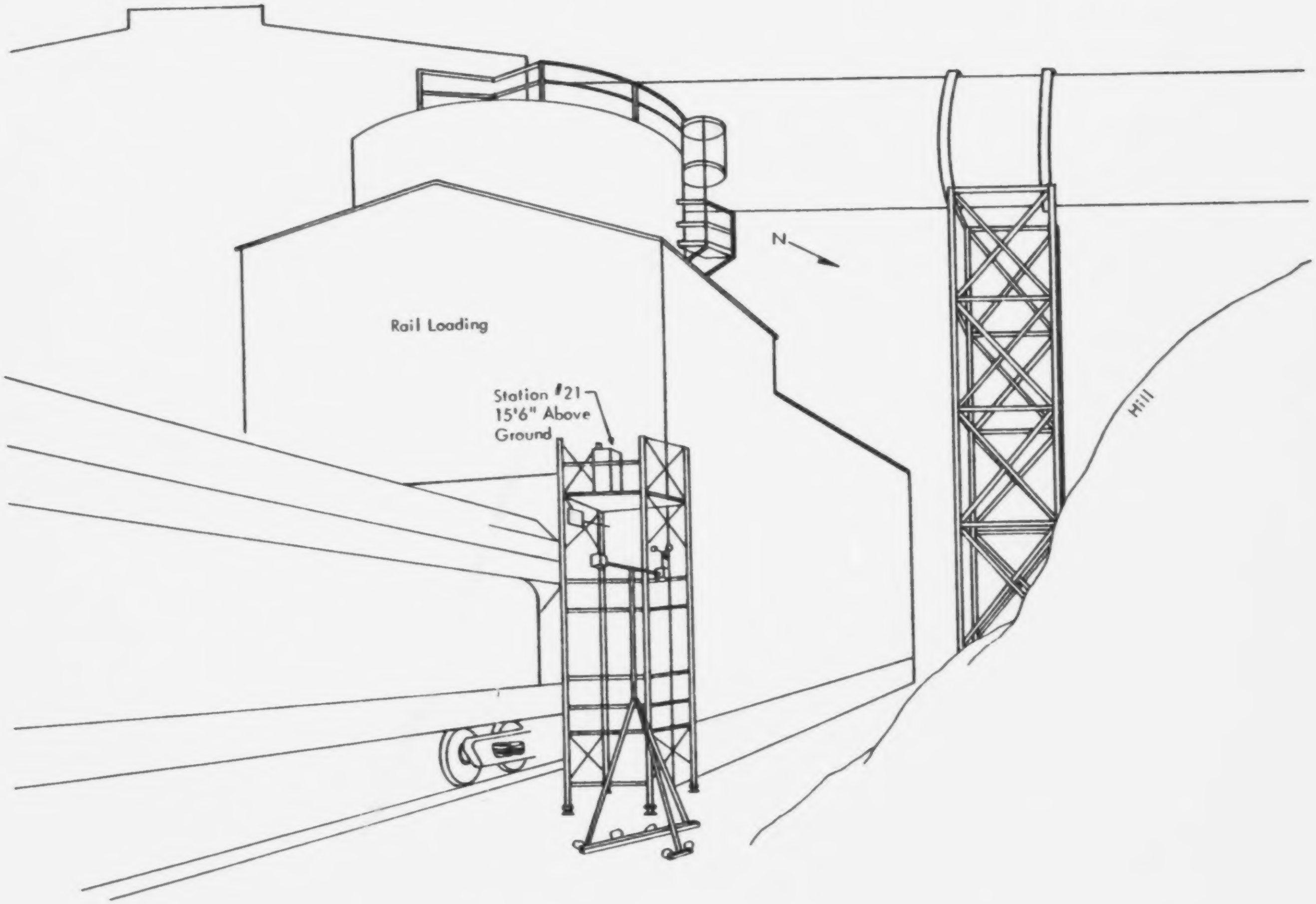

Rail Loading
Station #21
15'6" Above
Ground
N
Hill

Figure B-16 - Perspective View of Zinc-Fume Rail Loading, Indicating Location 21

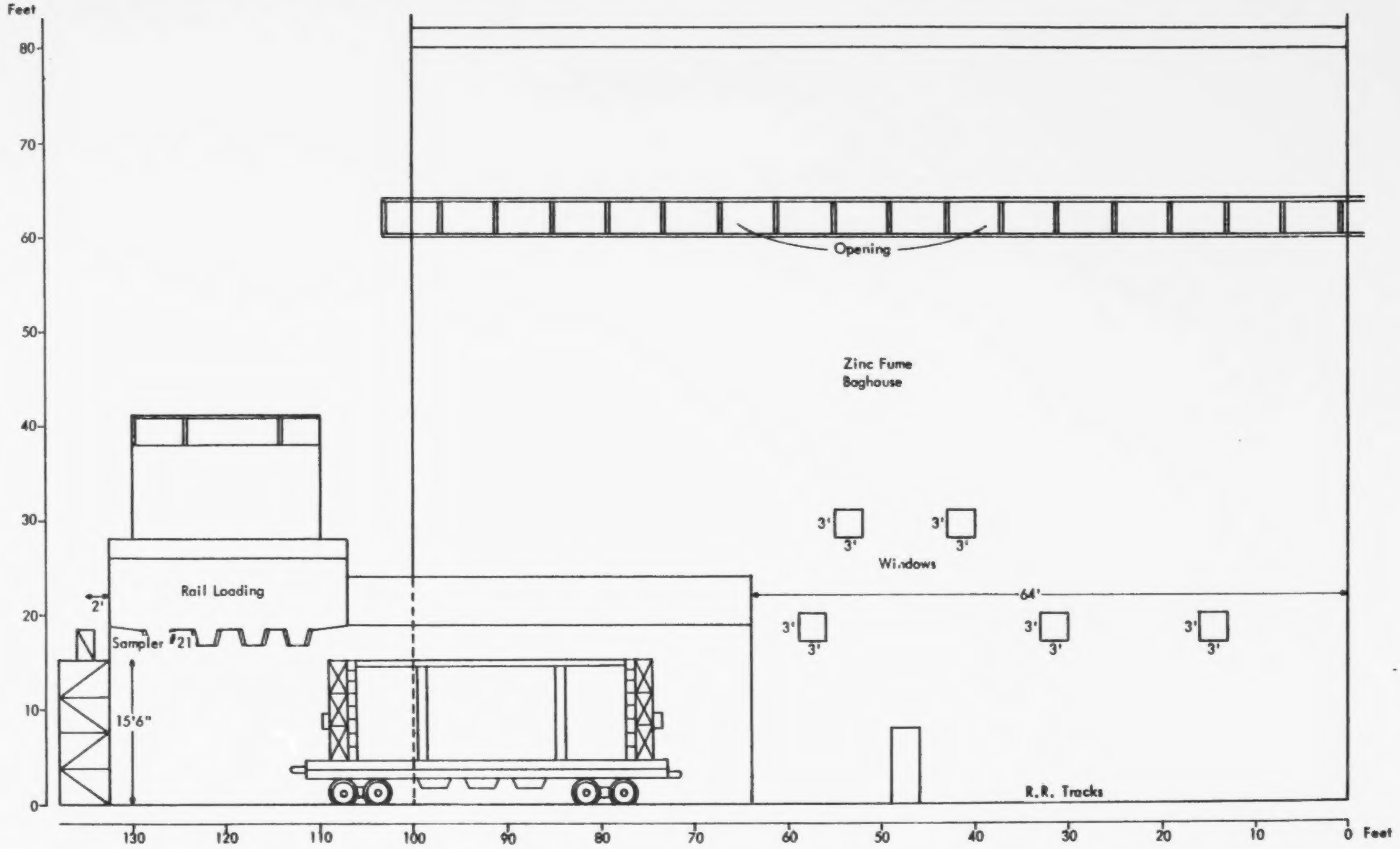

Feet
80
70
60
50
40
30
20
10
0
Opening
Zinc Fume
Boghouse
3'
3'
Windows
64'
Rail Loading
2'
Sampler #21
15'6"
R.R. Tracks
130
120
110
100
90
80
70
60
50
40
30
20
10
0 Feet

Figure B-17 - Detail, Northeast Side of Zinc-Fume Building, Indicating Location 21

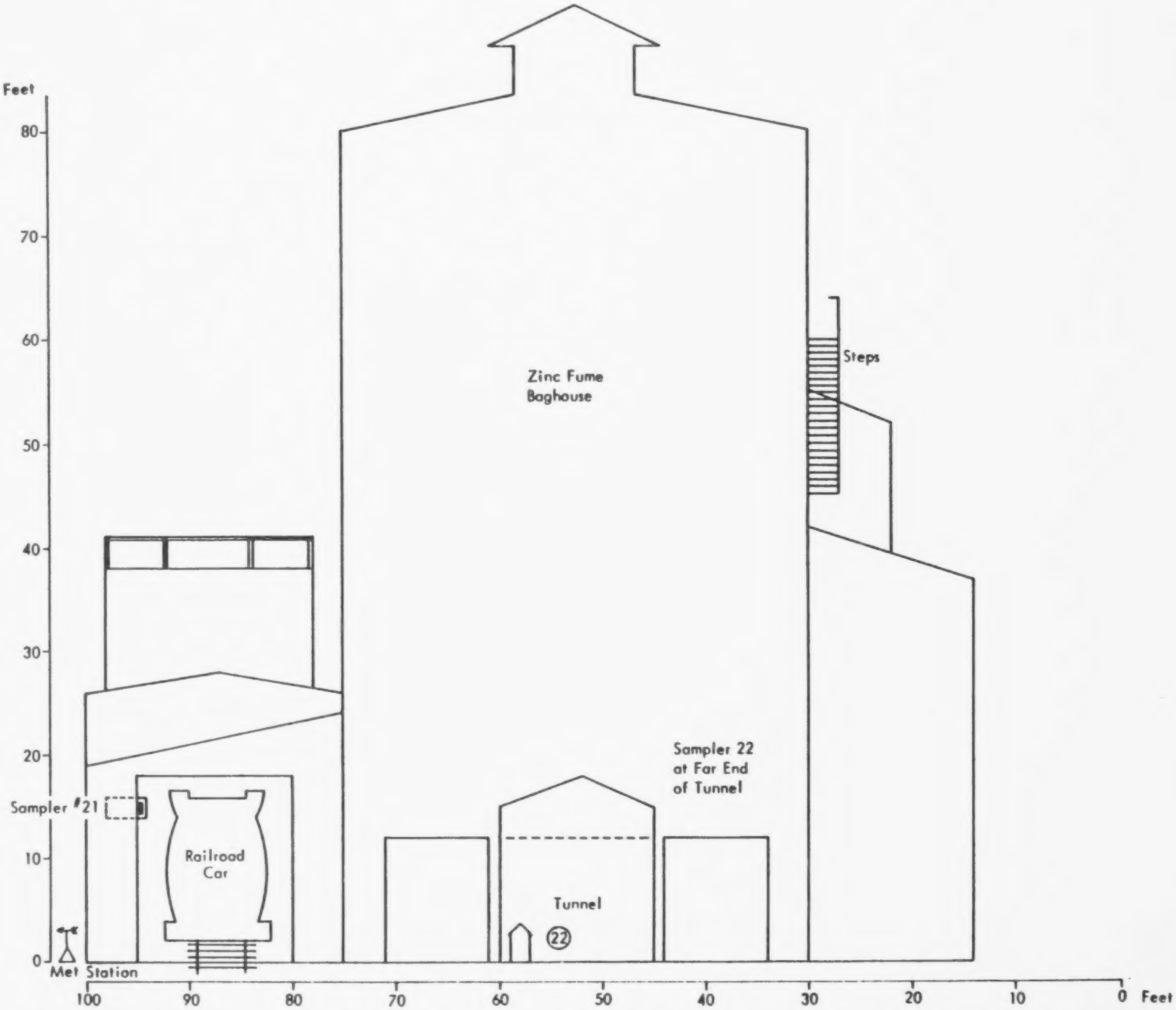

Feet
80
70
60
50
40
30
20
10
0
Zinc Fume Baghouse
Steps
Sampler 22 at Far End of Tunnel
Tunnel
22
Sampler #21
Railroad Car
Met Station
100
90
80
70
60
50
40
30
20
10
0
Feet

Figure B-18 - Detail, Northwest Side of Zinc-Fume Building, Indicating Locations 21 and 22

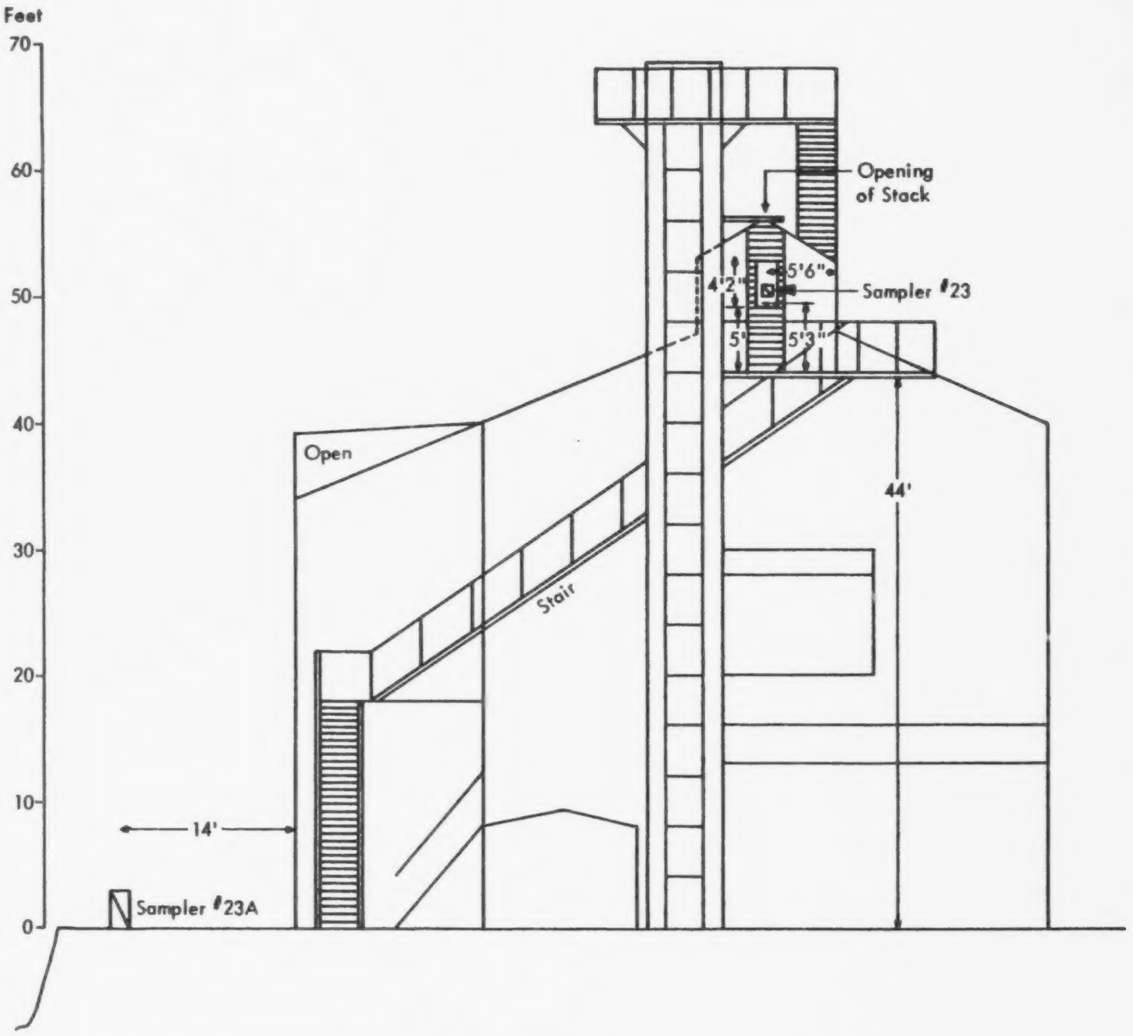

Feet
70
60
50
40
30
20
10
0
Opening of Stack
4'2"
5'6"
Sampler #23
5'
5'3"
Open
44'
Stair
14'
Sampler #23A

Figure B-19 - Detail, Northeast Side of Zinc-Furnace Building, Indicating Locations 23 and 23A

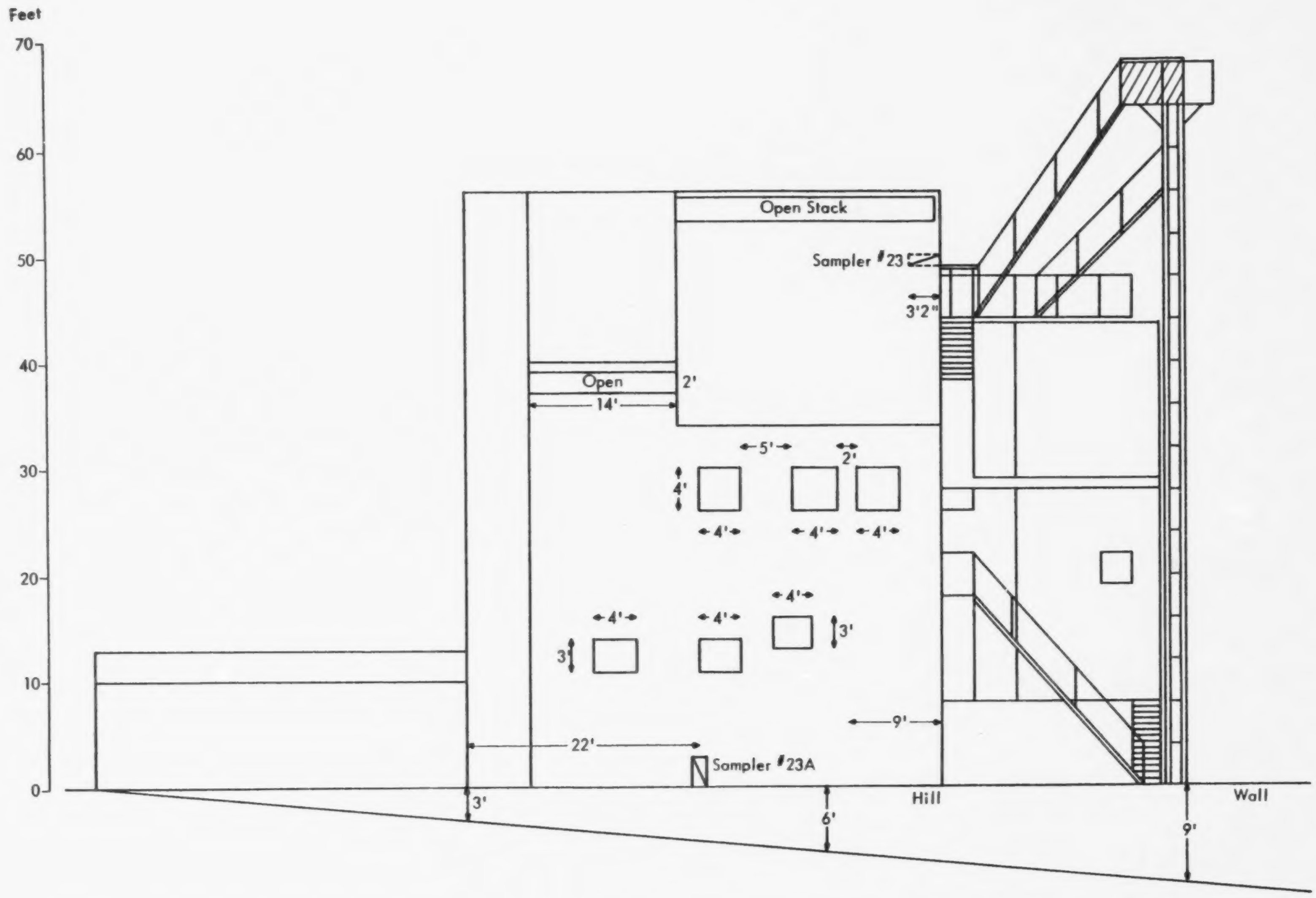

Feet
70
60
50
40
30
20
10
0
Open Stack
Sampler #23
3'2"
Open
2'
14'
5'
2'
4'
4'
4'
4'
4'
4'
4'
3'
3'
22'
9'
Sampler #23A
3'
6'
Hill
Wall
9'

Figure B-20 - Detail, Southeast Side of Zinc-Furnace Building, Indicating Locations 23 and 23A

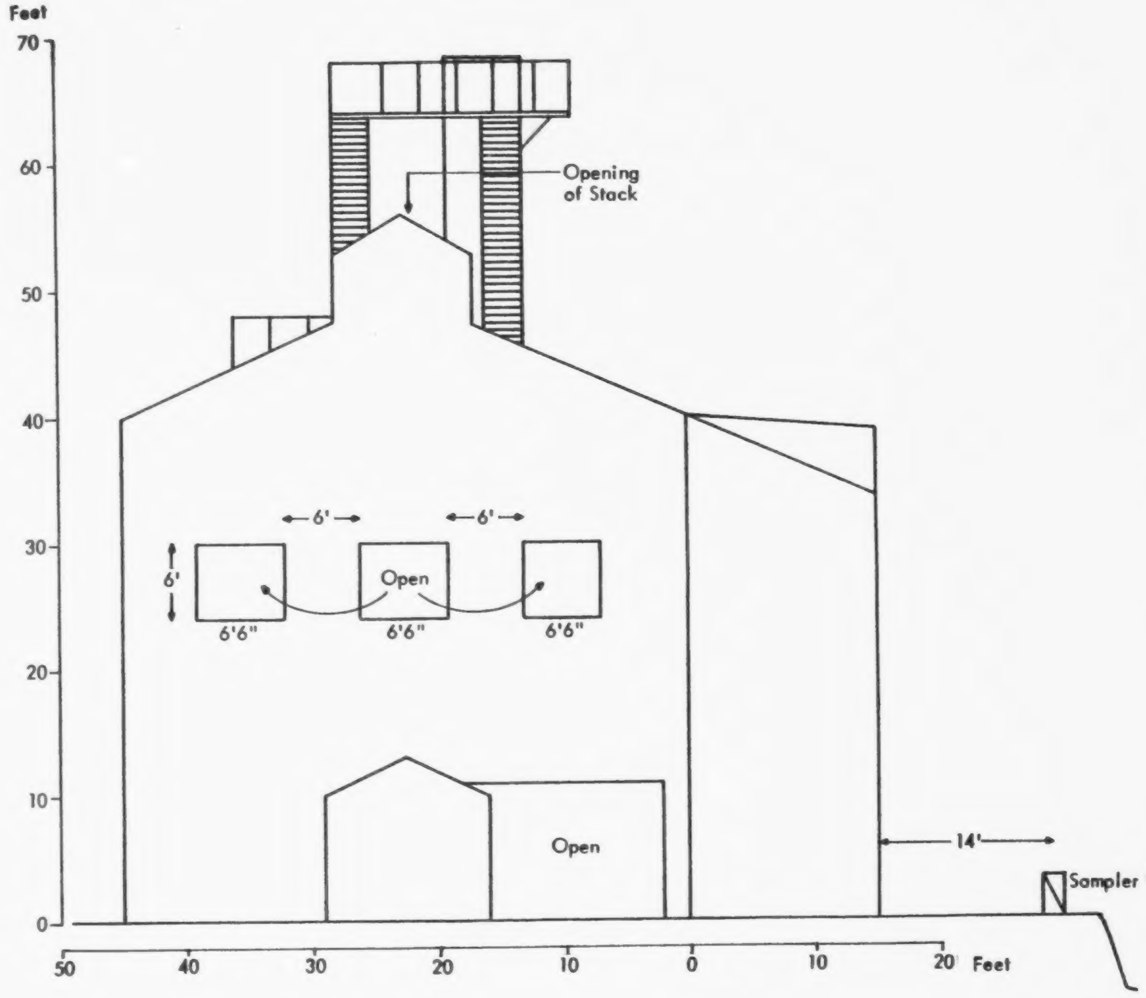

Feet
70
60
50
40
30
20
10
0
Opening of Stack
6'
6'
6'
Open
6'6"
6'6"
6'6"
Open
14'
Sampler #23A
50
40
30
20
10
0
10
20
Feet

Figure B-21 - Detail, Southwest Side of Zinc-Furnace Building, Indicating Location 23A

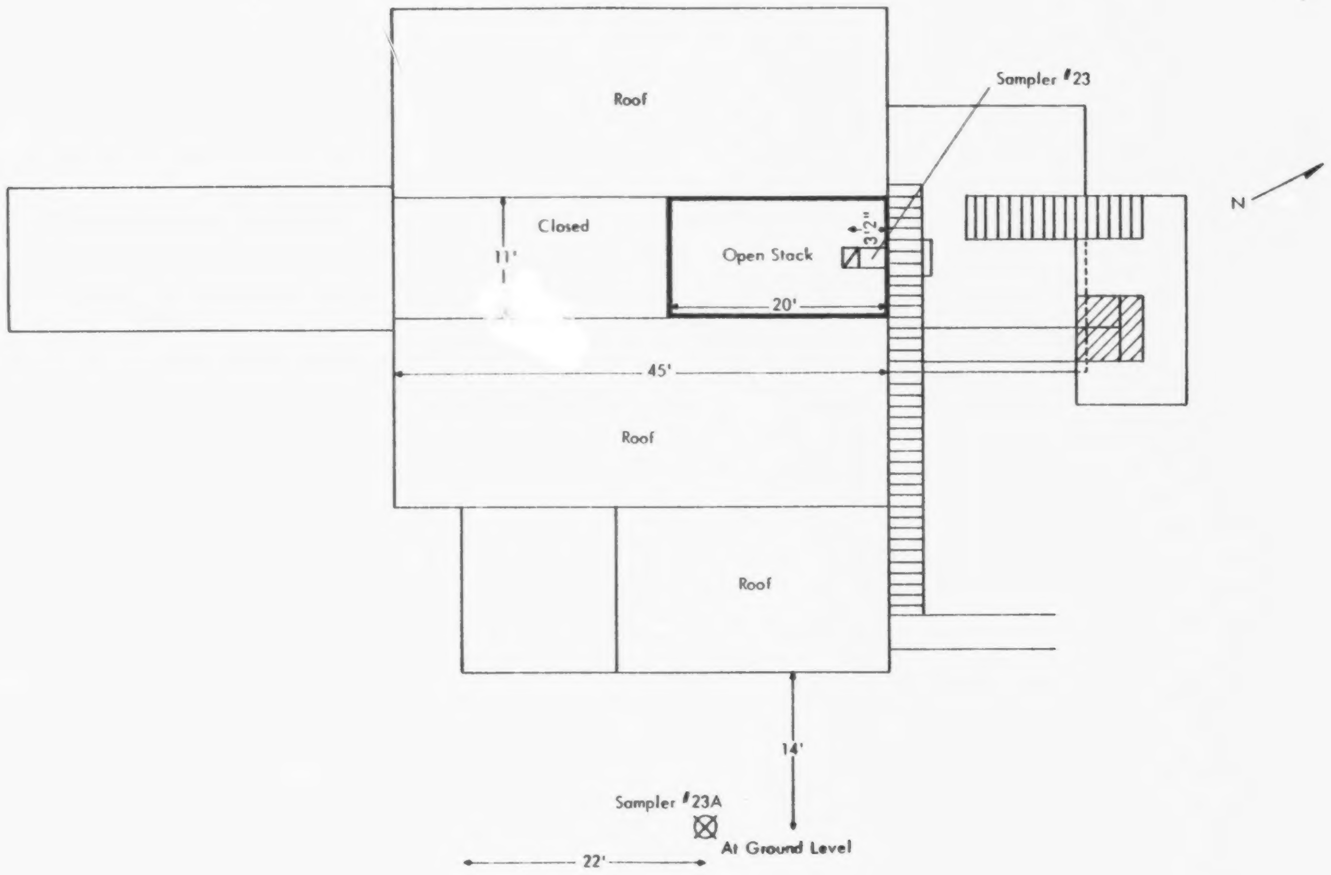

Roof
Sampler #23
N
Closed
11'
Open Stack
3'2"
20'
45'
Roof
Roof
14'
Sampler #23A
At Ground Level
22'

Figure B-22 - Detail, Roof of Zinc-Furnace Building, Indicating Locations 23 and 23A

APPENDIX C

PHOTOGRAPHS OF FIELD SAMPLING EQUIPMENT

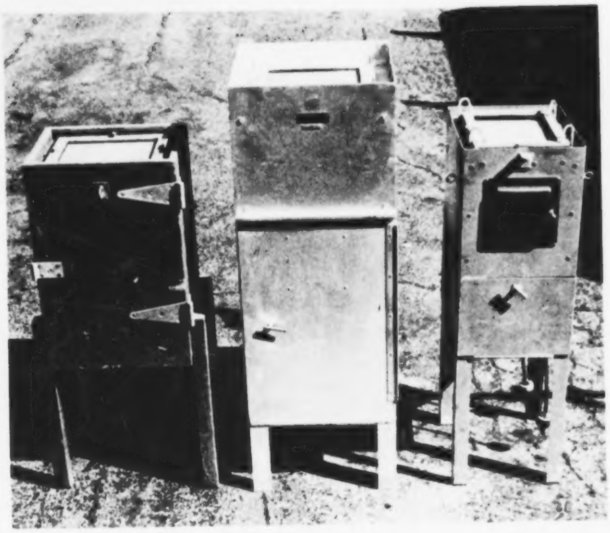


Figure C-1

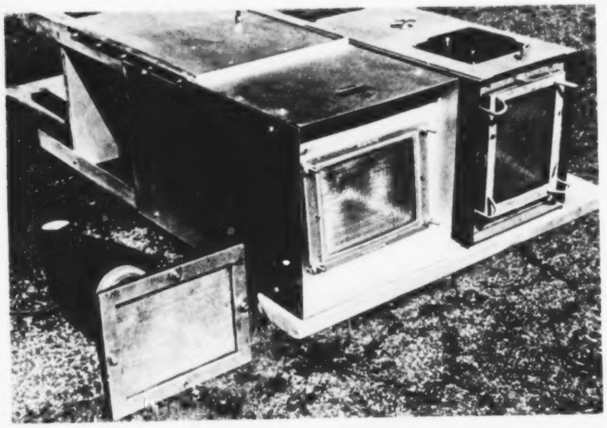


Figure C-2

Figure C-1 - HiVol Samplers in Upright Operation Mode, Three Types: Left to Right, "Hand-Held" Unico Model 550 in Cabinet, General Metal Works GMWL 2000-H, Curtin 251-223

Figure C-2 - HiVol Samplers in Horizontal Mode, Left to Right, "Hand-Held" Without Cabinet, General Metal Works, Curtin

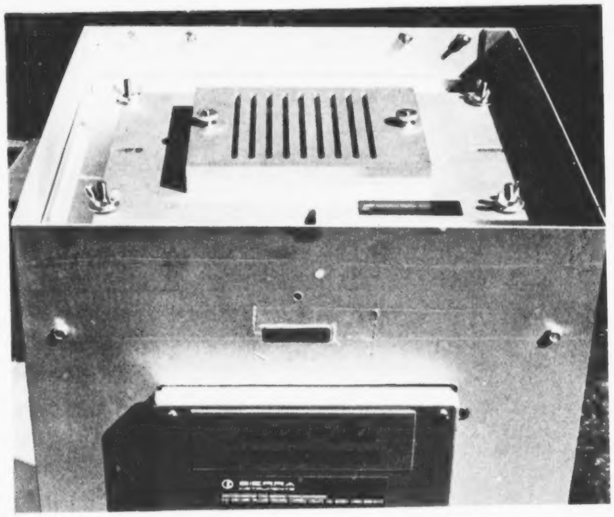


Figure C-3

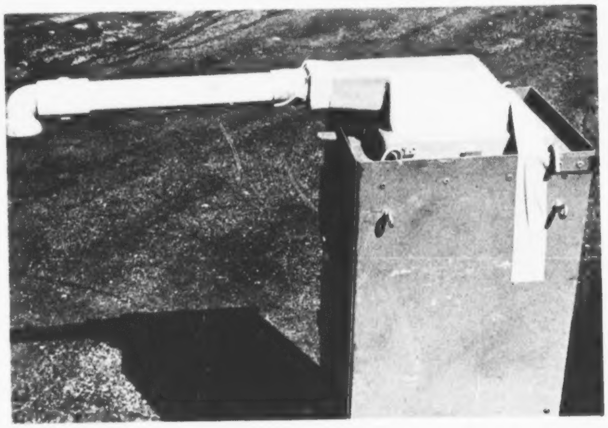


Figure C-4

Figure C-3 - Detail of Sierra 5-Stage Impactor in Position on General Metal Works Model 310 "Accuvol" Sampler

Figure C-4 - Detail of Auxiliary Intake in Position on HiVol, Used at Sampling Locations 12 and 20. Intake is at 90-degree bend (left).

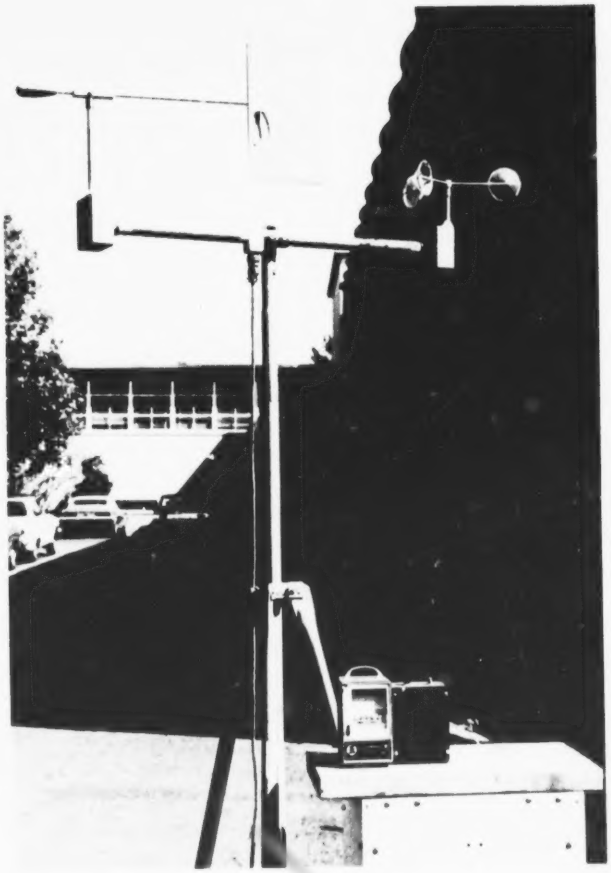


Figure C-5

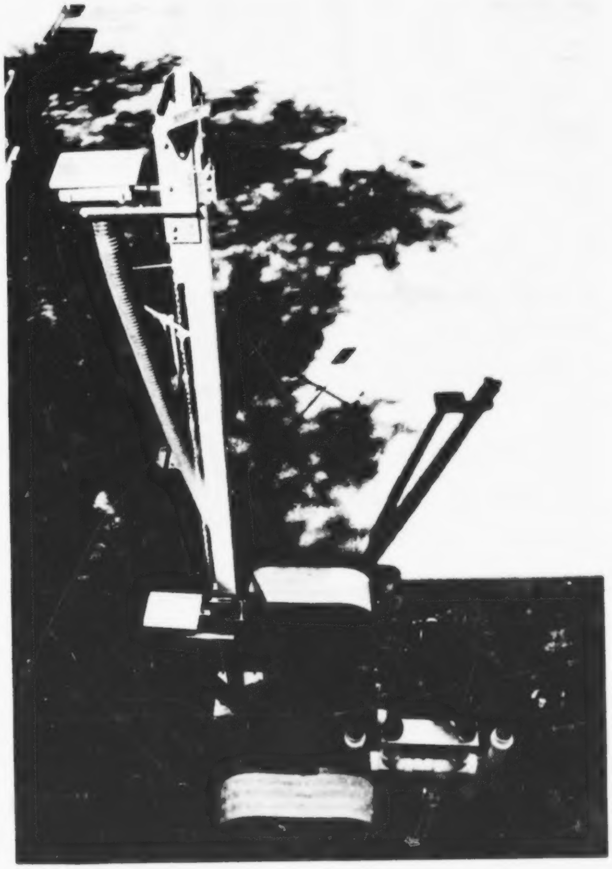


Figure C-6

Figure C-5 - Detail of Meteorological Station and Data Recorder, Wong Laboratories Ecowind III

Figure C-6 - Detail of Profile Apparatus Used at Location 1 (Glover, Missouri, Plant). Intakes are white rectangles, 7 in. x 9 in. openings. Top intake is 14 ft, 6 in. above ground; bottom is 6 ft, 6 in. above ground.

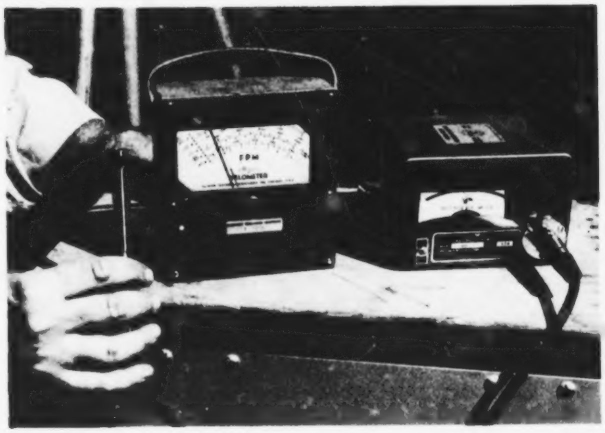


Figure C-7

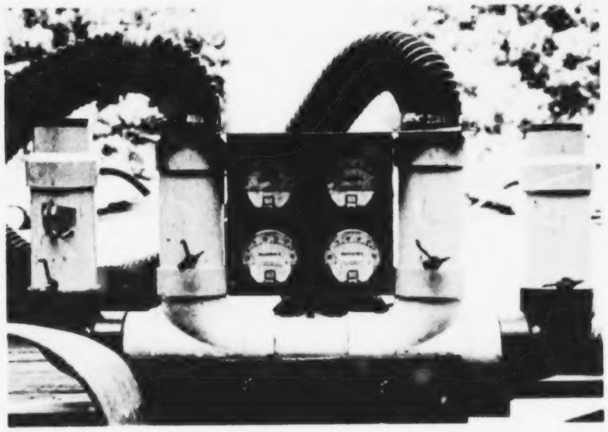


Figure C-8

Figure C-7 - Two Types of Low Velocity Sensors Used in the Field Determination of Air Velocity: Left, Sensor Probe of Hastings Air Meter AB-27. Center, Illinois Testing Laboratory "Alnor 3002-2G" Velometer. Right, gauge and electronic components of Hastings Air Meter.

Figure C-8 - Detail, Profile Apparatus and Magnetic Gauges. Tornado Model 8700 DPW Blower is behind, at lower part of U-shaped manifold.

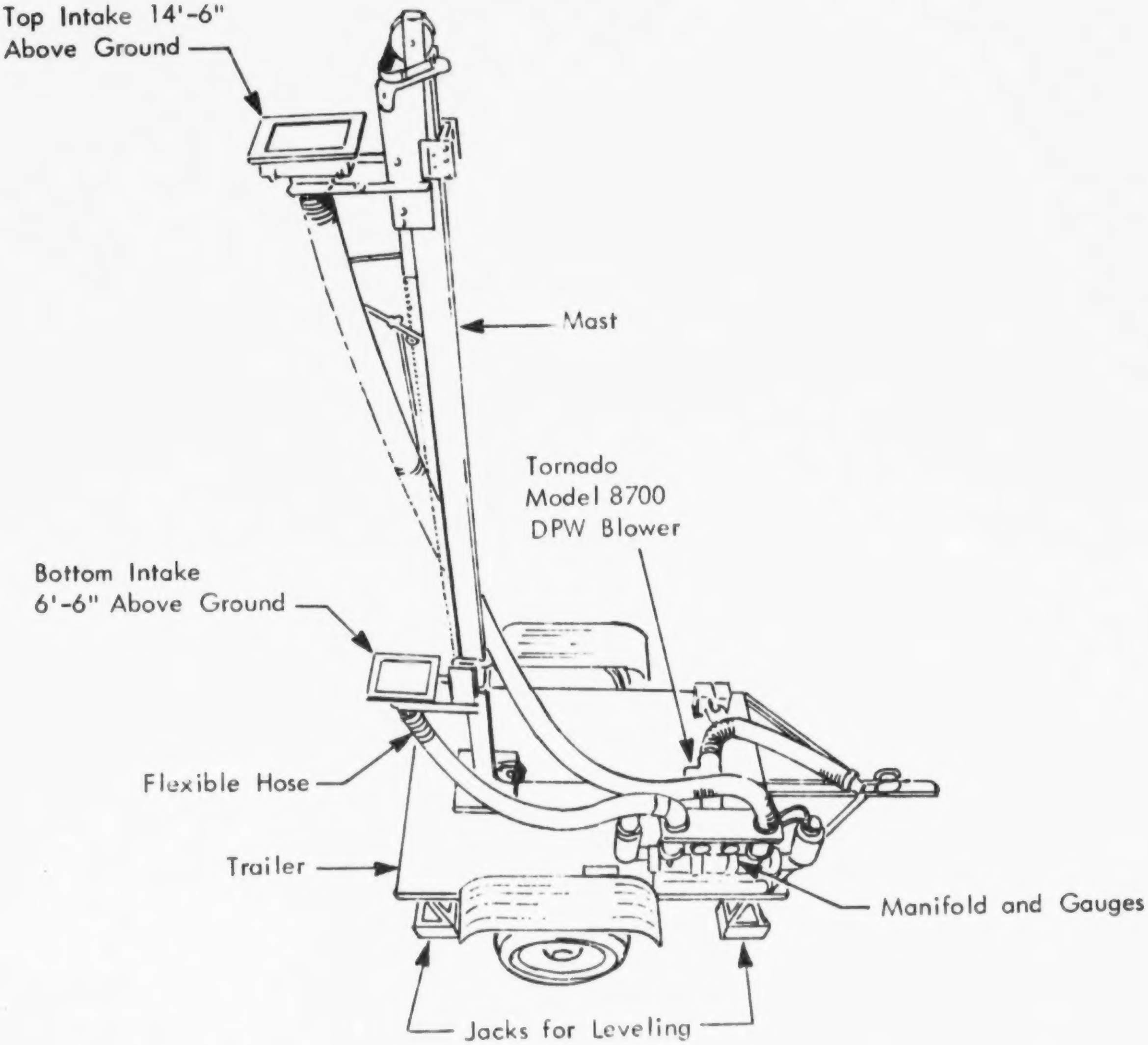

Top Intake 14'-6"
Above Ground
Mast
Tornado
Model 8700
DPW Blower
Bottom Intake
6'-6" Above Ground
Flexible Hose
Trailer
Manifold and Gauges
Jacks for Leveling

Figure C-9 - The MRI Vertical-Profile Sampling Apparatus

APPENDIX D

PHOTOGRAPHS OF SAMPLING LOCATIONS AT THE ASARCO PLANT, GLOVER, MISSOURI

PHOTOGRAPHS OF SAMPLING LOCATIONS OF THE ASARCO PLANT, GLOVER, MISSOURI

Sampling Locations		
No.	Point	Figures
1	North end of Sinter Bldg.	D-1
2N	Roof opening of Sinter Bldg.	D-2
2S	Roof opening of Sinter Bldg.	-
3	Inside, north of blast-furnace tapping operation	D-3
3A	East of blast furnace	-
4	Inside, north of charge-feed position of blast furnace	D-4, D-5
4A	Outside, west of charge inlet to blast furnace	-
5	North of ore-storage bins	D-4, D-5
5A	West of ore-storage bins	-
6	On truck to rail car ore transfer bridge	D-6, D-8
6N	Ground level north of transfer bridge	D-6
6S	Ground level south of transfer bridge	D-7

Figure Title Page

D-1 Sinter Building, Location 1. . . . . D-3

D-2 Sinter Building, Location 2N D-3

D-3 Blast-Furnace Area, Location 3 . . . . D-3

D-4 Blast-Furnace Ore-Bin Area, Locations 4 and 5. . . . . . D-3

D-5 Ore-Bin Area, Locations 4 and 5. . . . . D-4

D-6 Ore-Unloading Area, Locations 6 and 6N D-4

D-7 Ore-Unloading Area, Location 6S. D-4

D-8 Ore-Unloading Area, Location 6 . . . . D-4

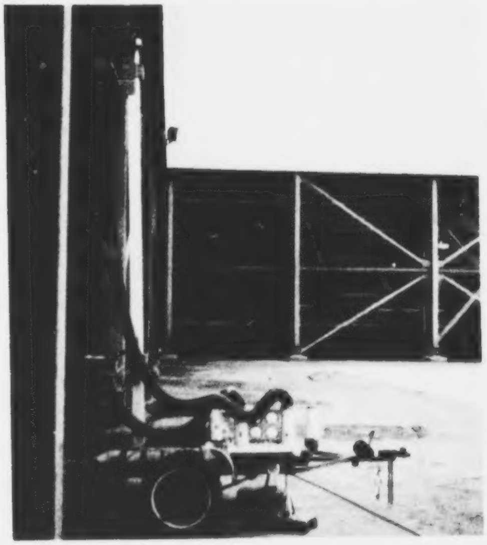


Figure D-1 - Sinter Building, Location 1. Profile apparatus in position at Bay 1 of north side of sinter building. Sampling intakes are at left margin of picture in the plane of the face of the building.

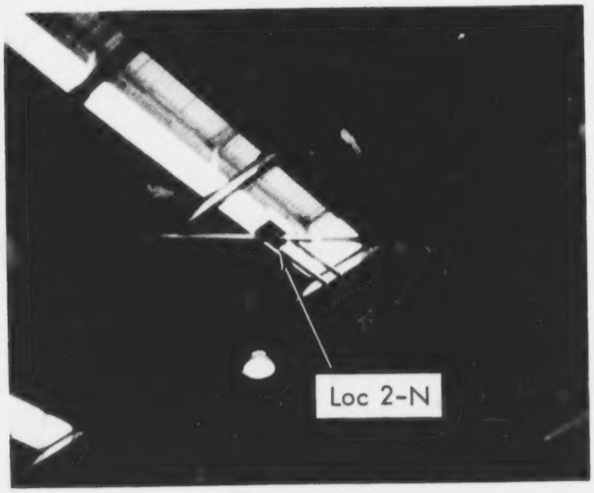


Figure D-2 - Sinter Building, Location 2N. Viewed from below, sampler in position at roof opening of sinter building. Location 2S similar in appearance.

Figure D-3 - Blast-Furnace Area, Location 3. Oblique view of sampler atop office roof adjacent to blast furnace. Visible from left to right are the meteorological station, Accuvol with Sierra impactor, and HiVol sampler.

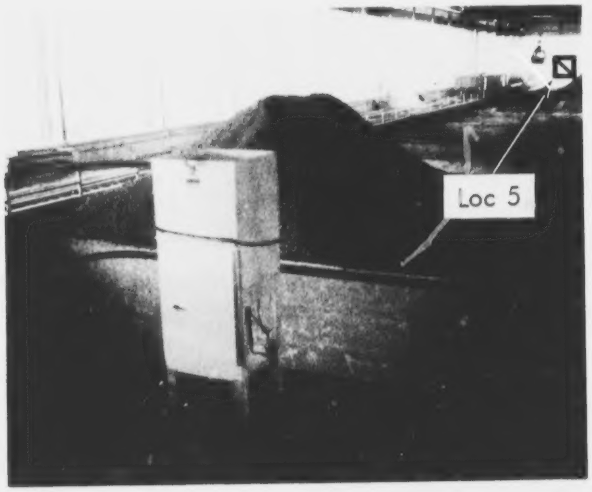


Figure D-4 - Blast-Furnace Ore-Bin Area, Locations 4 and 5. Sampler (foreground, Location 4) between blast furnace and ore-bin area. Location 5 in background.

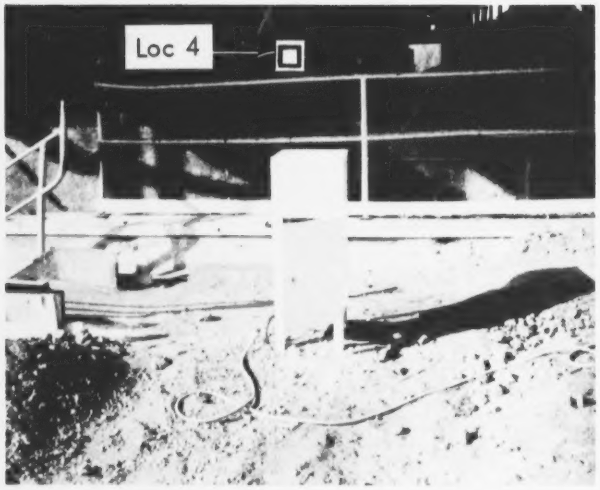


Figure D-5 - Ore-Bin Area, Locations 4 and 5. Sampler (foreground, Location 5) to north of ore and material storage bins. Rail car dump is at right of picture. Location 4 in background.

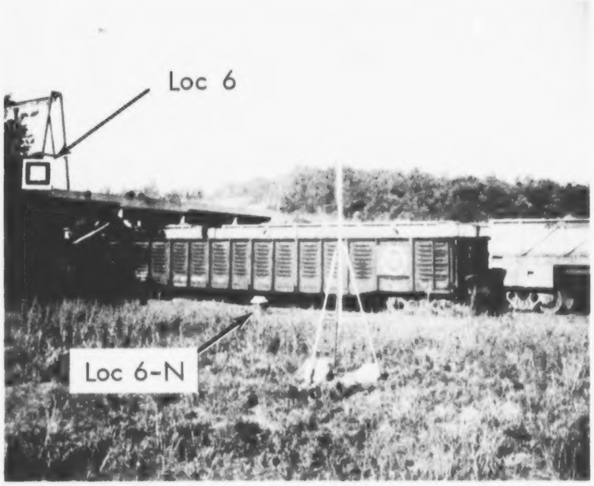


Figure D-6 - Ore-Unloading Area, Locations 6 and 6N. Samplers at site when ore transferred from trucks to rail cars. Meteorological station at center foreground.

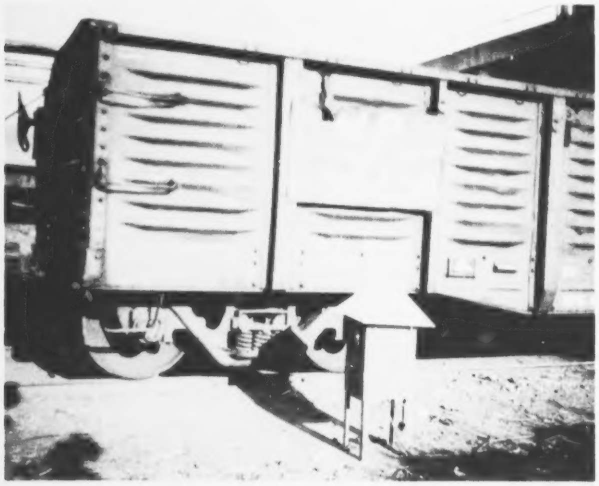


Figure D-7 - Ore-Unloading Area, Location 6S. Sampler adjacent to ore hopper car. HiVol cover is on due to an earlier rain shower.

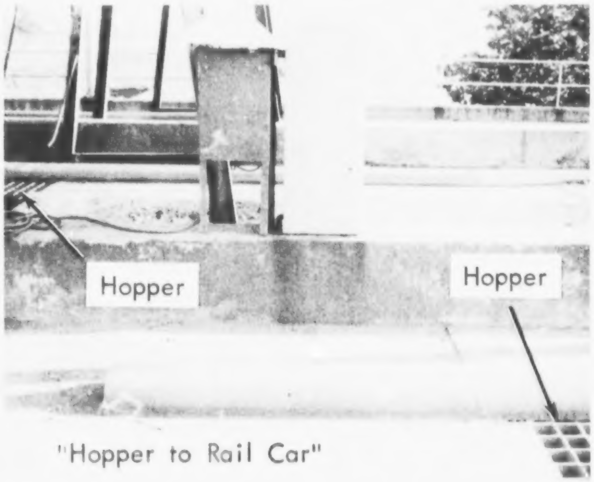


Figure D-8 - Ore-Unloading Area, Location 6. Sampler atop overpass adjacent to hopper gratings. Ore dumped from trucks on overpass, through gratings, into rail cars below. HiVol covered due to an earlier rain shower.

APPENDIX E

PHOTOGRAPHS OF SAMPLING LOCATIONS AT THE ASARCO PLANT, EAST HELENA, MONTANA

PHOTOGRAPHS OF SAMPLING LOCATIONS AT THE ASARCO PLANT, EAST HELENA, MONTANA

Sampling Locations		Figure
No.	Point	
11	Roofing opening	-
12	Vent duct	E-1 to E-3
13	Windows, top level east	E-1, E-2
14	Windows, middle level east	E-2
14A	Windows, middle level east	-
15	North windows, sinter level	-
16	South windows, sinter level	-
17	Dross operations	E-4
18	Reverberatory furnace	E-3, E-4
19	Blast-furnace roof opening	E-5
20	Blast-furnace vent duct	E-5
21	Rail-loading, zinc fuming	E-7, E-8
22	Tunnel, zinc-fuming	E-6
23	Zinc-furnace, roof opening	E-9
23A	Ground level vicinity zinc furnace	-
24N	Ore-loading - north	-
24S	Ore-loading - south	E-10

Figure	Title	Page
E-1	Sinter Building, Locations 12 and 13.	E-3
E-2	Sinter Building, Locations 12 to 14	E-3
E-3	Sinter and Dross-Reverberatory Buildings, Locations 12 and 18.	E-3
E-4	Dross and Reverberatory Building, Locations 17 and 18 .	E-3
E-5	Blast-Furnace Building, Locations 19 and 20	E-4
E-6	Zinc-Fume Building, Location 22	E-4
E-7	Zinc-Fume Building, Location 21	E-4
E-8	Zinc-Fume Building, Location 21	E-4
E-9	Zinc-Furnace Building, Location 23.	E-5
E-10	Ore Bins, Location 24S.	E-5

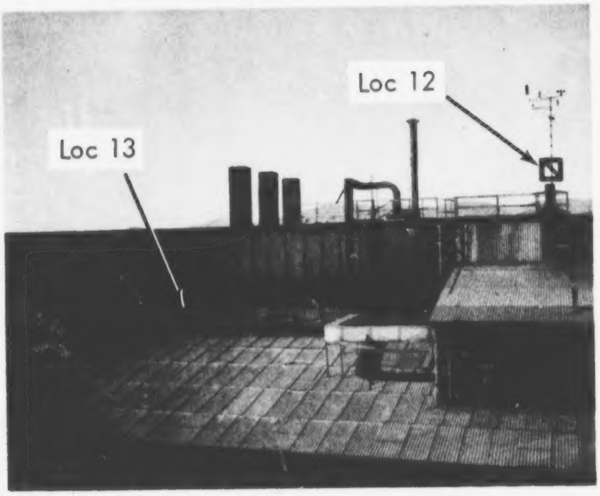


Figure E-1 - Sinter Building, Locations 12 and 13. Northeast side of building. Plant meteorological station directly behind Location 12.

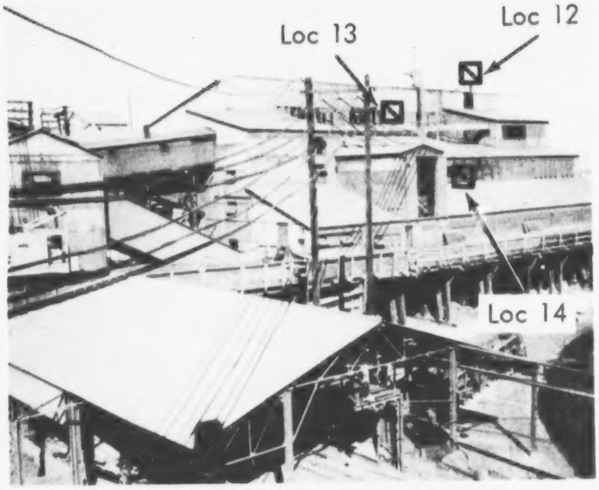


Figure E-2 - Sinter Building, Locations 12 to 14. Northeast side of sinter building. Blast-furnace charge-car loading area in shed (foreground). Plant meteorological station adjacent to Location 12.

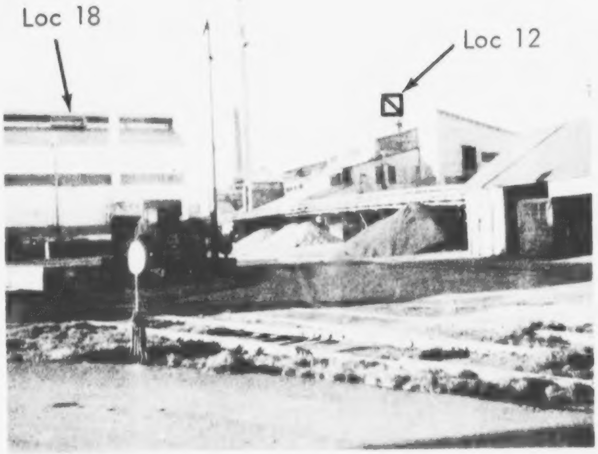


Figure E-3 - Sinter and Dross-Reverberatory Buildings, Locations 12 and 18. Plant meteorological station adjacent to Location 12.

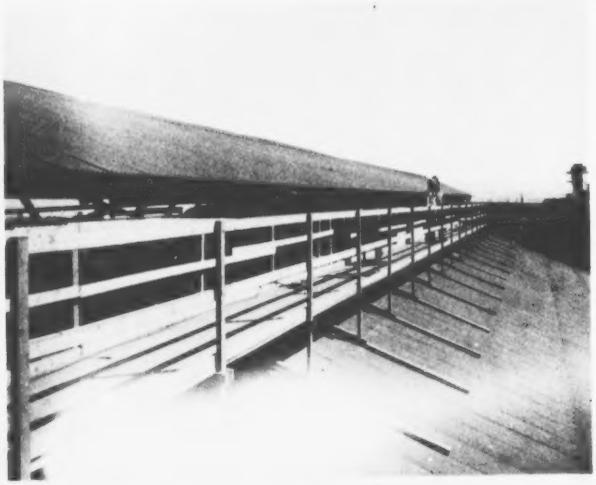


Figure E-4 - Dross and Reverberatory Building, Locations 17 and 18. Catwalk atop building, dross sampler (Location 17) located background, reverberatory sampler (Location 18) located foreground. Sampler removed when photo taken.

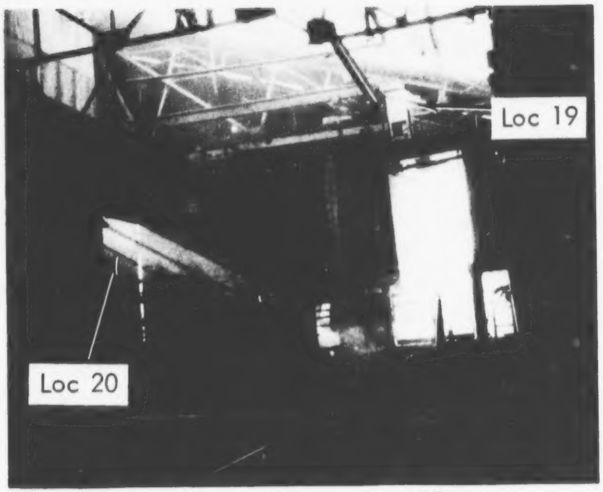


Figure E-5 - Blast-Furnace Building, Locations 19 and 20. Blast furnace in lower center.

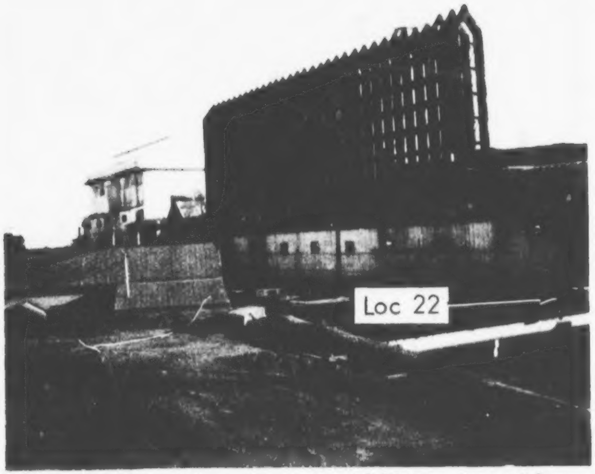


Figure E-6 - Zinc-Fume Building, Location 22. Zinc-fume condensing column in center; baghouse at left center.

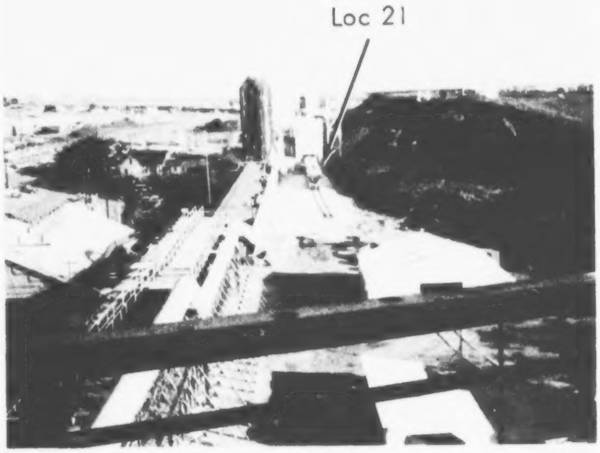


Figure E-7 - Zinc-Fume Building, Location 21. Zinc-furnace building in left foreground. Process line extends to zinc-fume condensing columns. Baghouse to rear and rail car loading facilities to right of columns. Plant meteorological station located atop zinc-fume baghouse stack (right background).

Figure E-8 - Zinc-Fume Building, Location 21. Sampler located horizontally atop scaffolding center (sampler removed when photo taken). MRI meteorological station located between scaffold and bank (right).

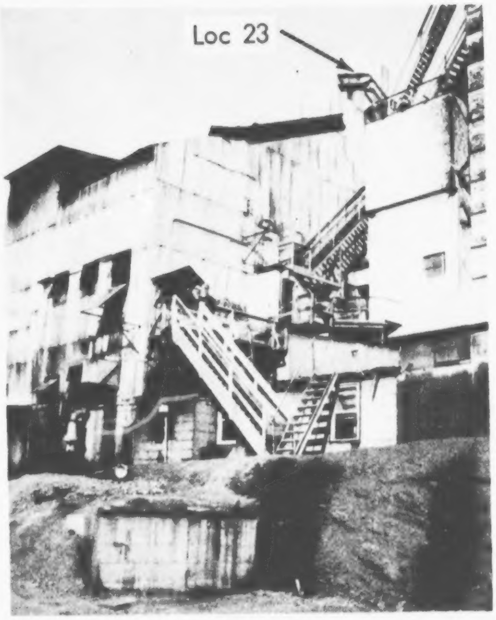


Figure E-9 - Zinc-Furnace Building, Location 23. East corner of building. Location 23 in stack at top. Location 23A out of picture to left.

Figure E-10 - Ore Bins, Location 24S. Rail cars just behind bins and power shovel. Sinter building in far background.

APPENDIX F

GRAPHS OF ESCA (ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS) RESULTS ON SPECIES DETERMINATION

August 25, 1976

Mr. Mark Marcus
MIDWEST RESEARCH INSTITUTE
425 Volker Blvd.
Kansas City, Missouri 64110

Re: P.O.# 2421
Job # 6053

Dear Mark:

Enclosed you will find ESCA spectra for the specimens submitted for analysis. All studies were performed in our ESCA/Auger ultra high vacuum system using a magnesium anode for X-ray stimulation of photoelectrons.

The ESCA spectra are presented as the photoelectron energy distribution as a function of binding energy. The scale sensitivities have been recorded on each chart in units of counts per second per inch. The peak height of each photoelectron line is proportional to atomic concentration. Some of the data were obtained utilizing the high energy resolution capabilities of the double pass cylindrical mirror analyzer. The absolute instrumental resolution is approximately 2% of the pass energy indicated in the upper right-hand corner of each chart.

RESULTS

I have also enclosed tables for the binding energies of Pb, and S compounds as well as a sample calculation of the atomic concentrations for one specimen. As you will recall, during your visit there was some question whether or not Pb sulfate or Pb sulfide could be identified. I will try to indicate in the report where Pb sulfide is indicated by the data. I have enclosed a table giving the corrected binding energies for Pb and S for each sample. I have also listed the Pb peak width (FWHM) which I believe to be indicative of the presence of other bonds other than Lead oxide.

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Specimen #3000

The survey spectrum of this specimen shows that the surface constituents were O, C, Na, S, Pb and Si. In this case, I believe that very little of the S was associated with the Pb. The Pb peak width was approximately 2.1 eV which is one of the narrower peak widths measured. Also, the peak symmetry (or asymmetry) indicates the possibility of a lower binding energy state but not a higher binding energy state that could be associated with a Pb sulfide or Pb sulfate. The Pb binding energy is consistent with PbO and with the possibility of a small amount of PbO_2 present. The S binding energy is consistent with the sulfate such as Na sulfate.

Specimen #3001

The survey spectrum of this specimen shows that the surface constituents were O, C, Na, S and Pb. Again, there is little evidence of strong association between Pb and S. The binding energies are consistent with PbO and S as a sulfate. After sputtering this specimen (approximately 200A removed) both sulfate and sulfide were apparent from the S photoelectron spectrum. The Pb photoelectron peak, however, did not change significantly.

Specimen #3002

The as received spectrum of this specimen shows that the surface constituents were O, Ca, C, Na, S, Pb and Si. Here, the Pb photoelectron spectrum indicates two surface bonds which are consistent with PbO and PbO_2. S was present as a sulfate.

Specimen #3003

The as received spectrum of this specimen shows that the surface constituents were O, Ca, C, Na, S, Pb and Si. Again, PbO, PbO_2 and sulfate are indicated on the surface.

Specimen #3004

The as received spectrum of this specimen shows that the surface constituents were O, C, Na, Pb and Si. Very little S was detected at the surface. Pb and S spectra indicates the presence of PbO, PbO_2 and sulfate. After sputtering of this specimen (approximately 200A removed) Pb and S binding energies were consistent with PbO and a sulfide.

Specimen #2007

The as received spectrum of this specimen shows that the surface constituents were O, C, Na, S, Pb and Si. Here, Pb binding energies were consistent with PbO and PbO_2. There is little if any evidence of Pb-S bonding in any form. Both sulfate and sulfides are indicated on the surface.

Specimen #2027

The as received spectrum of this specimen shows that the surface constituents were O, C, Na, S, Cl and Pb. Binding energies were consistent with PbO, a chloride and a sulfate. Again, no evidence of Pb-Cl or Pb-S bonding. After removing approximately 50A from the surface, the Cl concentration increased. However all chemical bonds appeared to remain the same at this depth.

Specimen #2032

The survey spectrum of this specimen shows that the surface constituents were O, C, Na, S, Pb and Si. PbO (with a small amount of PbO_2) was the dominant Pb species.

Specimen #2033

The as received spectrum of this specimen shows that the surface constituents were O, Ca, C, Na, S, Pb and Si. Both PbO and PbO_2 were present at the surface. S was found to be in both sulfate and sulfide forms.

Specimen #2047

The as received spectrum of this specimen shows that the surface constituents were O, Ca, C, Na, S, Pb and Si. Pb was predominantly in the form of PbO and S in the form of a sulfate.

Specimen #2042

The as received spectrum of this specimen shows that the surface constituents were O, C, Na, S, Si and Pb. Pb was predominantly PbO but the S was 50% sulfate and 50% sulfide.

Specimen #2039

The as received spectrum of this specimen shows that the surface constituents were Zn, O, N, Ca, C, Na, Cl, S, Si and Pb. The Pb spectrum here possibly indicates the presence of

Pb sulfide at a binding energy of 141 eV. The dominant species, however, was PbO with small amounts of PbO_2 present. At the surface, S was in the form of a sulfate and a sulfide. After removing 100A from the surface the Pb spectrum was still indicative of Pb sulfide and most of the S at this depth was in the form of a sulfide.

Specimen #3042

The as received spectrum of this specimen shows that the surface constituents were Zn, O, Pb, Ca, C and S. The dominant Pb species at the surface was PbO. There was no evidence of Pb sulfide or Pb sulfate bonding.

Specimen #3043

The as received spectrum of this specimen shows that the surface constituents were Zn, C, Pb, Ca, Na, S and Si. Again, the dominant Pb species were PbO and PbO_2.

Specimen #3044

The as received spectrum of this specimen shows that the surface constituents were Zn, O, Pb, Ca, C, Na, S and Si. The dominant Pb species at the surface was PbO.

Specimen #3045

The as received spectrum of this specimen shows that the surface constituent were Zn, O, Ca, K, C, Na, S, Pb and Si. The Pb photoelectron spectrum was indicative of PbO.

Specimen #3046

The as received spectrum of this specimen shows that the surface constituents were Zn, O, Ca, K, C, Na, S, Pb and Si. Again, the Pb spectrum was indicative of PbO.

Specimen #2069

The as received spectrum shows that the surface constituents were Zn, O, Ca, K, C, Na, S, Pb and Si. PbO and PbO_2 were the dominant Pb species at the surface.

Specimen #3062

The as received spectrum of this specimen shows that the surface constituents were Zn, O, C, Na, S, Pb, Si and As. The dominant Pb species at the surface was PbO .

Specimen #3063

The as received spectrum of this specimen shows that the surface constituents were Zn, O, C, Na, S, Pb, Si and As. The dominant Pb species at the surface was PbO.

Specimen #3064

The as received spectrum of this specimen shows that the surface constituents were O, N, C, Na, S, Pb and As. PbO was the dominant Pb species at the surface.

Specimen #3065

The as received spectrum of this specimen shows that the surface constituents were Zn, O, N, C, Na, Pb and As. The main Pb species at the surface was PbO.

Specimen #3066

The as received spectrum of this specimen shows that the surface constituents were O, C, Na, S, Pb and As. The main Pb species at the surface was PbO.

Specimen #2103

The as received spectrum of this specimen shows that the surface constituents were Na, Zn, O, Pb, N, C, Na, S, Pb and As. The dominant Pb species at the surface was PbO.

SUMMARY

The only specimen where Pb sulfide on the surface was clearly indicated was specimen #2039. In all other cases, the dominant Pb species were PbO and PbO_2. Specimens #3062 through #3066 and specimen #2108 all had As on the surface.

I hope that you find these results satisfactory and that we can continue to be of service. Please don't hesitate to contact me if I have left any questions unanswered.

Sincerely,

PHYSICAL ELECTRONICS INDUSTRIES, INC.

Larry Davis

Dr. L. E. Davis, Director,
Analytical Laboratory

LED:jh

Enclosures

CORRECTED BINDING ENERGIES (eV)

Sample	Pb 4f$_{7/2}$	Pb FWHM	S 2p
3000	139.1	2.1	169
3001	139.1	2.1	169
" after sputtering	139.0	2.3	169 162
3002	139.2 137.4	2.3	169
3003	139.1	2.3	169 162
3004	139.1 137.4	2.9	169 162
" after sputtering	139.1	2.5	162
2007	139.1 137.4	3.0	169 162
2027	139.4	2.0	169
2027 after sputtering	139.1	2.2	169 162
2032	139.1	2.2	169
2033	139.0	2.5	169
2047	139.2	1.9	169 162
2042	139.3	2.0	169 162
2039 aft.	141 139 137	3.0	169 162
" after sputtering	141 139		
3042	139	2.2	169
3043	139	2.3	169
3044	139	2.3	169
3045	139	2.2	169
3046	139	2.2	169
2069	139	2.1	169
3062	139	2.1	169
3063	139	2.2	169
3064	139	2.1	169
3065	139	2.1	169
3066	139	2.1	169
2108	139	2.3	169

September 28, 1976

Mr. Marc Marcus
MIDWEST RESEARCH INSTITUTE
425 Volker Blvd.
Kansas City, Missouri 64110

Re: P.O.# 2421
Job # 6053

Dear Marc:

Enclosed you will find ESCA spectra for the balance of specimens submitted during your first visit. The procedure for analysis and data format are essentially as before. With the data you will find a table listing the Pb and S peak energies as well as the Pb peak width indicative of the presence of other bonds other than Pb oxide.

RESULTS

Specimen 3077

The survey spectrum of this specimen shows that the surface constituents were Na, O, C, Pb, Si, S and As. The S concentration on this sample was considerably lower than that found on most of the other samples. The As concentration on this specimen was relatively low compared to other samples in this series. The table shows that the Pb binding energy is consistent with PbO and the S binding energy is consistent with a sulfate. The peak width of the Pb photoelectron line suggests that there was only one Pb species.

Specimen 3078

The survey spectrum of this specimen shows that the surface constituents were Na, O, C, S, Pb, Si and As. The As concentration level in this specimen was greater than that found for 3077. The photoelectron binding energies for specimen 3078 suggest Pb existed as PbO and most of the S was sulfate. Possibly some sulfide was detected. The peak width suggests only one Pb species.

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Specimen 3079

The as received spectrum of this specimen shows that the surface constituents were Na, O, C, S, Pb, Si and As. Again, the As concentration was higher than the previous specimen. The photoelectron binding energies and Pb peak width are the same as that found for specimen 3078.

Specimen 3080

The survey spectrum of this specimen shows that the surface constituents were Na, Zn, O, C, S, Pb and As. Again, the As concentration was higher than that found for the previous specimens. Here, the Pb photoelectron binding energy was found to be slightly lower suggesting that some PbO_2 could have been present. The S binding energies suggest that most of the S was sulfate with the possibility of some sulfide being present.

Specimen 3081

The survey spectrum of this specimen shows that the surface constituents were Na, Zn, O, C, S, Si and As. This specimen had the highest As concentration of all the specimens in this series. The binding energy of the Pb photoelectrons again suggest the presence of PbO and PbO_2. S was predominantly in the form of a sulfate.

Specimen 2077

The surface constituents of this specimen were Na, Zn, O, Ni, Ca, C, S and Pb. The Zn concentration was considerably higher than on previous specimens. The binding energy and peak width of the Pb photoelectrons was consistent with PbO. S was predominantly in the form of sulfate.

Specimen 2099

The as received spectrum of this specimen shows that the surface constituents were Na, O, C, Si, Pb and Al. The Pb concentration of this specimen was considerably lower than that found on other specimens and S was not detected. The binding energy and Pb peak width, however, suggest that Pb sulfide was present. It is possible that the S was below the detectability limit.

Specimen 2100

The as received spectrum of this specimen shows that the surface constituents were Zn, O, N, C, S and Pb. The N concentration of this specimen was significantly higher than found on other specimens. Measurements of the photoelectrons suggest the presence of PbO and sulfates on the surface.

Specimen 2113

The as received spectrum of this specimen shows that the surface constituents were Na, Zn, O, Pb, N, C, S and As. Again, PbO and sulfates existed on the surface.

I hope that you find these results satisfactory and that we can continue to be of service. Please don't hesitate to contact me if I have left any questions unanswered.

Sincerely,

PHYSICAL ELECTRONICS INDUSTRIES, INC.

L. E. Davis

Dr. L. E. Davis, Director,
Analytical Laboratory

LED:jh

Enclosures

Sample	Pb4$f_{7/2}$	Pb FWHM	S2p	
3077*	138.9	2.3	170	
3078*	138.6	2.0	169	162?
3079*	138.6	2.0	169	162?
3080*	138.4	2.0	169	162?
3081*	138.3	2.0	169	162?
2077	139.2	2.1	169	162?
2099	141.0	2.4		
2100	139.2	2.1	169	
2113*	138.8	2.2	169	162

*Samples containing As

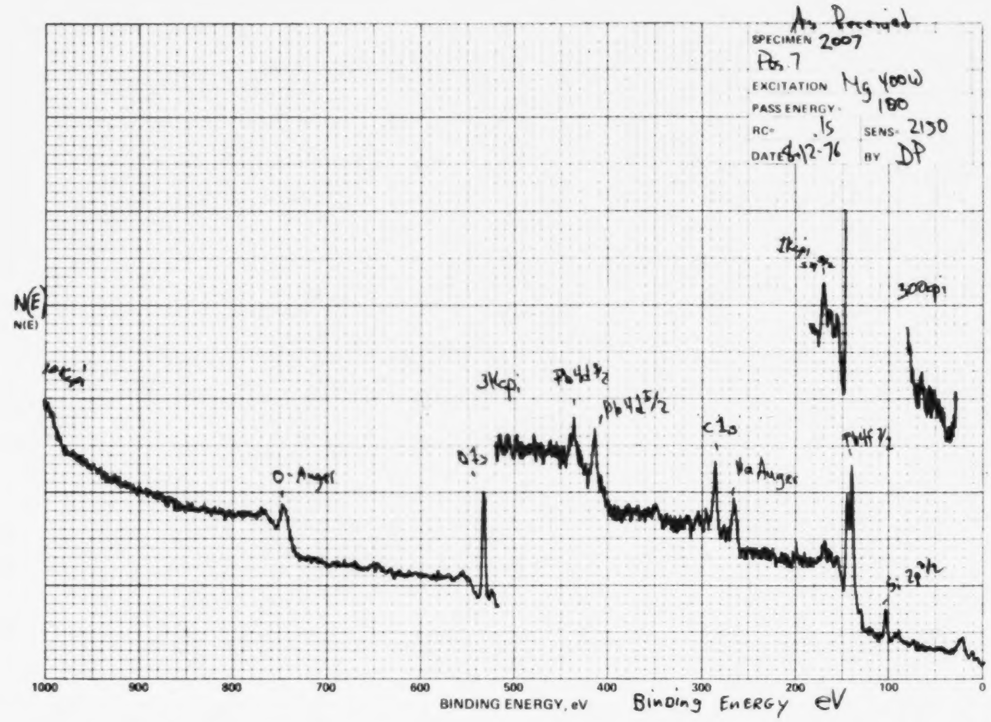

Figure F-1 - ESCA Graph - Run 1, Location 1B, Sierra Backup, Filter 2007

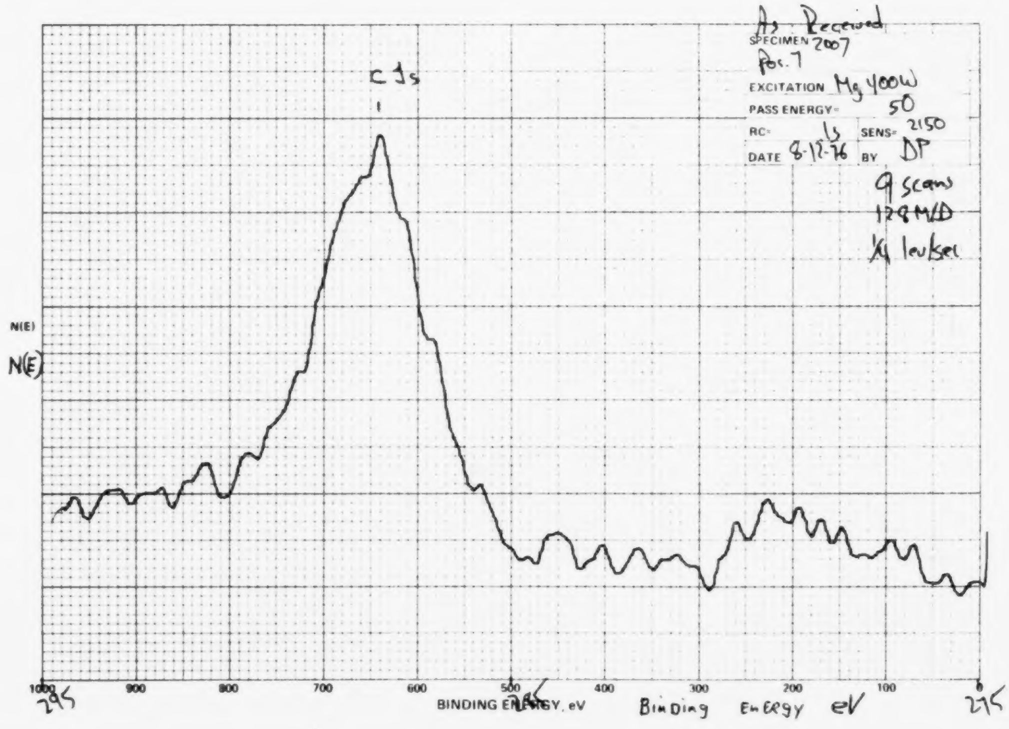

Figure F-2 - ESCA Graph - Run 1, Location 1B, Sierra Backup, Filter 2007

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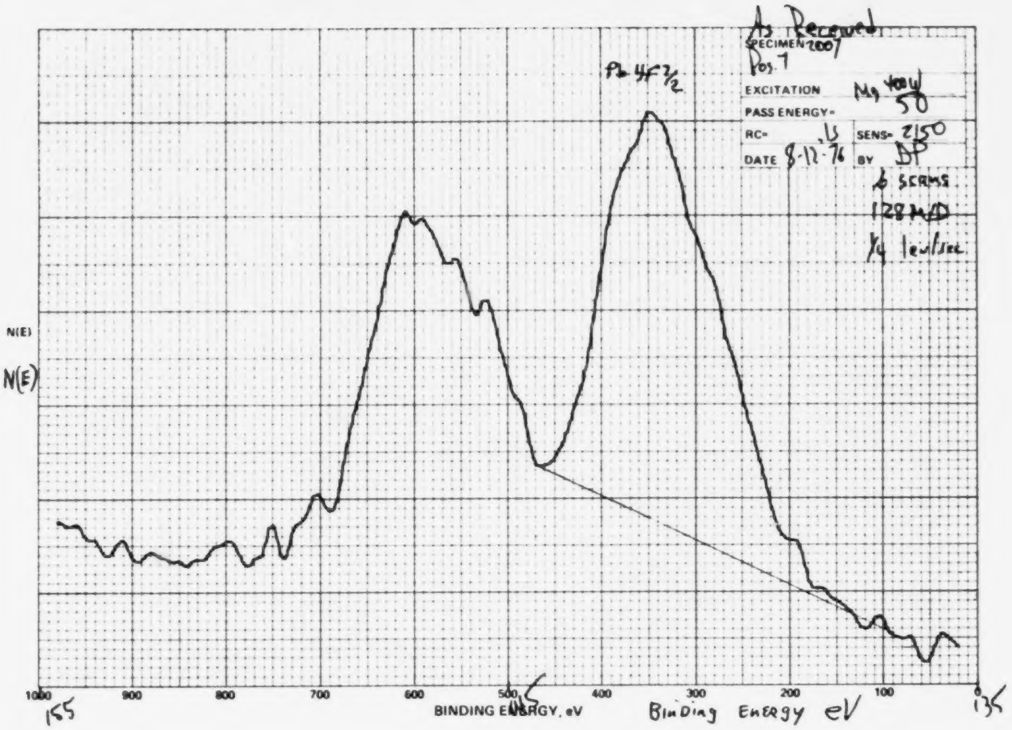


Figure F-3 - ESCA Graph - Run 1, Location 1B, Sierra Backup, Filter 2007

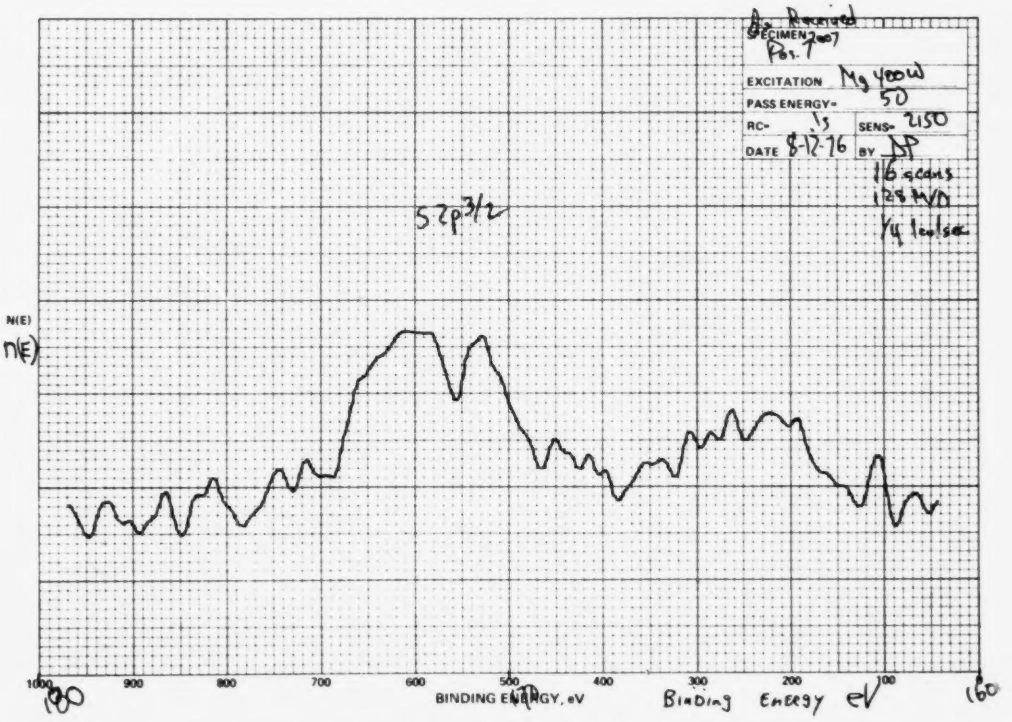


Figure F-4 - ESCA Graph - Run 1, Location 1B, Sierra Backup, Filter 2007

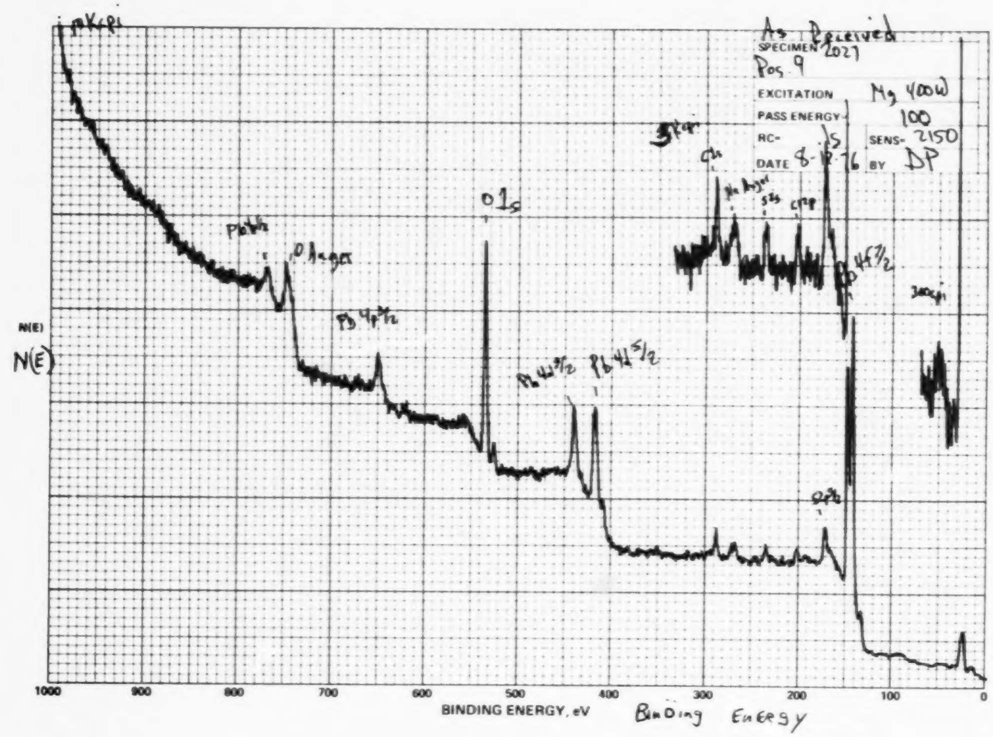


Figure F-5 - ESCA Graph - Run 5, Location 2N, Filter 2027

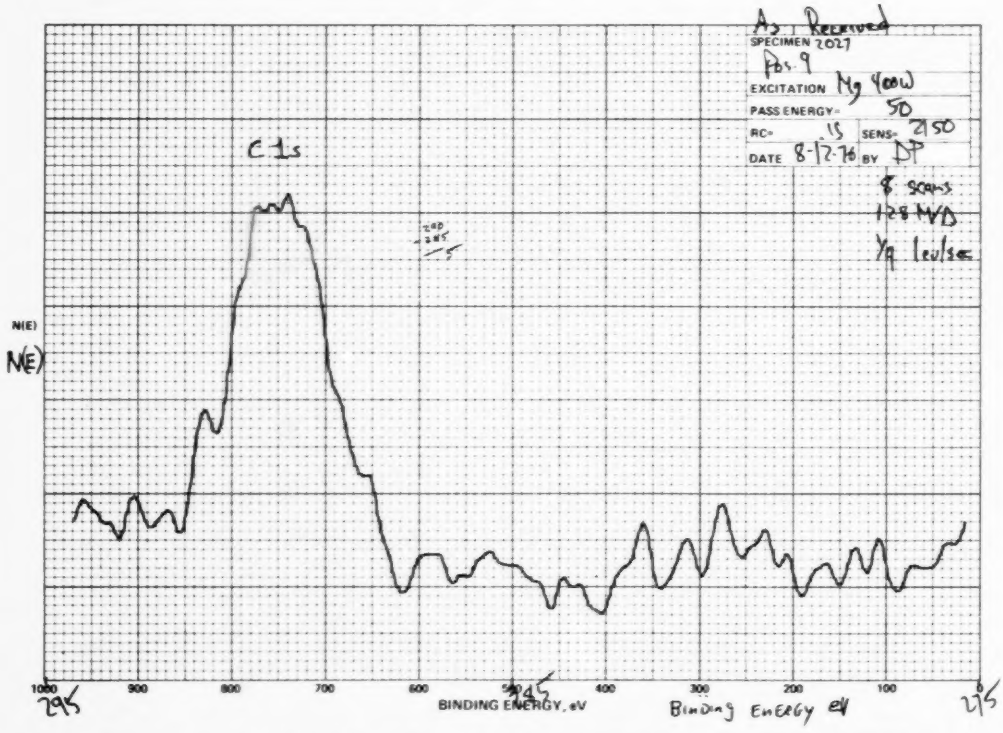


Figure F-6 - ESCA Graph - Run 5, Location 2N, Filter 2027

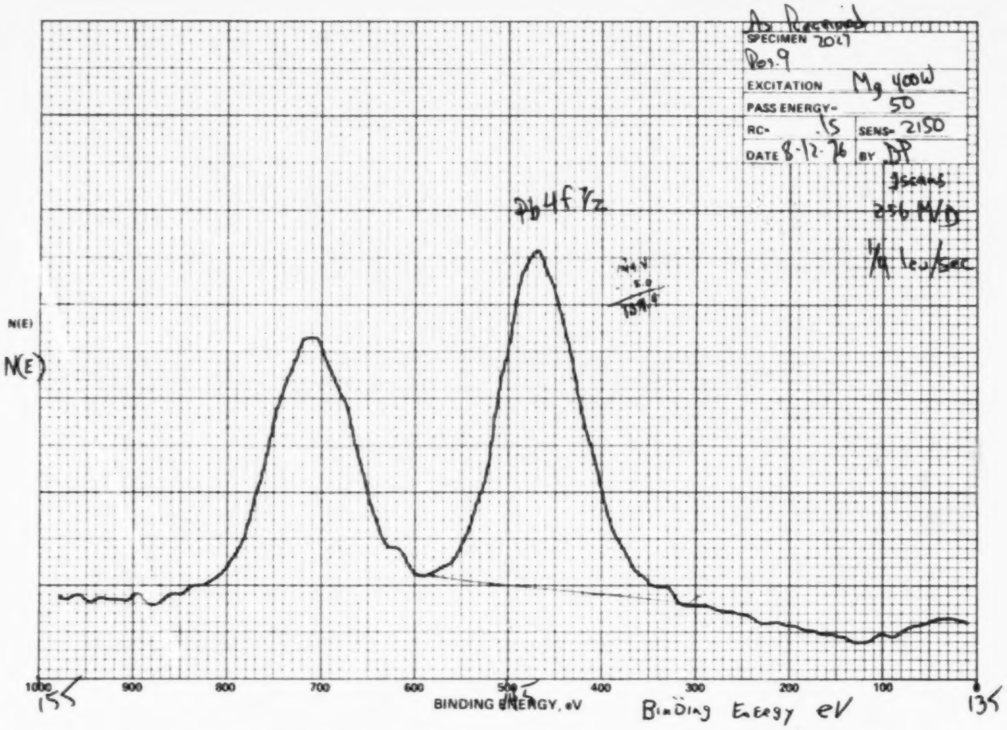


Figure F-7 - ESCA Graph - Run 5, Location 2N, Filter 2027

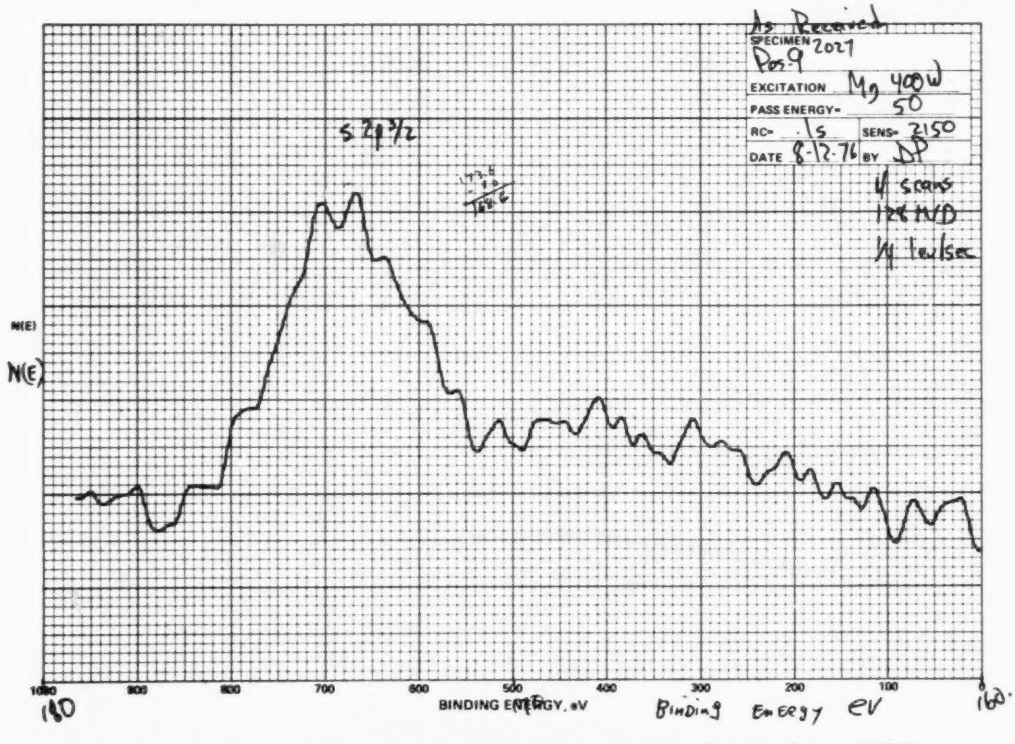


Figure F-8 - ESCA Graph - Run 5, Location 2N, Filter 2027

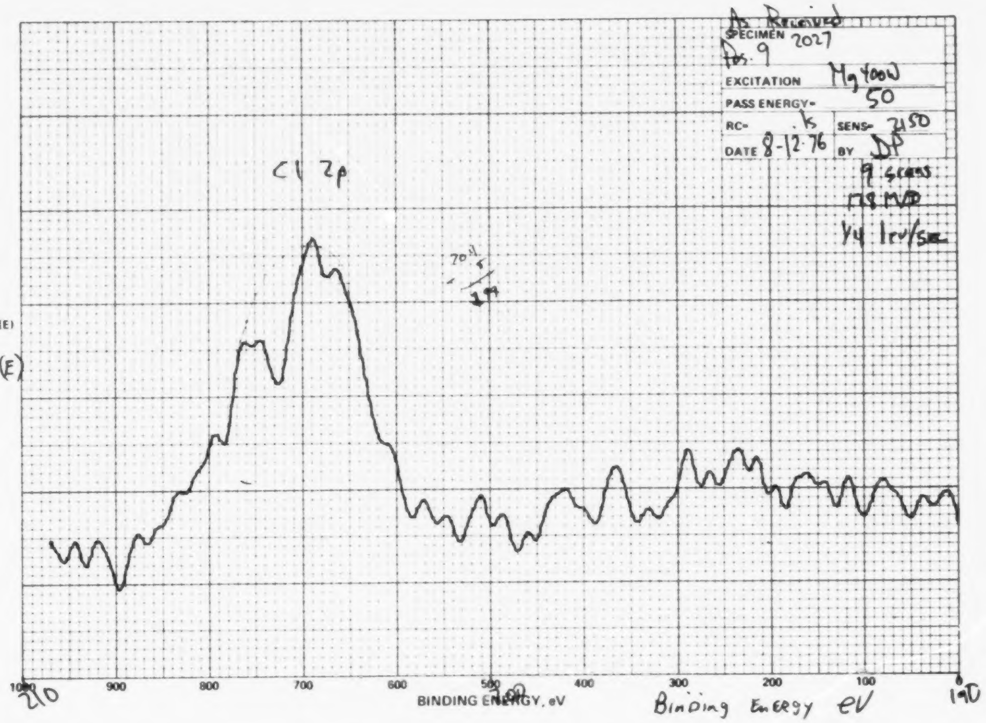


Figure F-9 - ESCA Graph - Run 5, Location 2N, Filter 2027

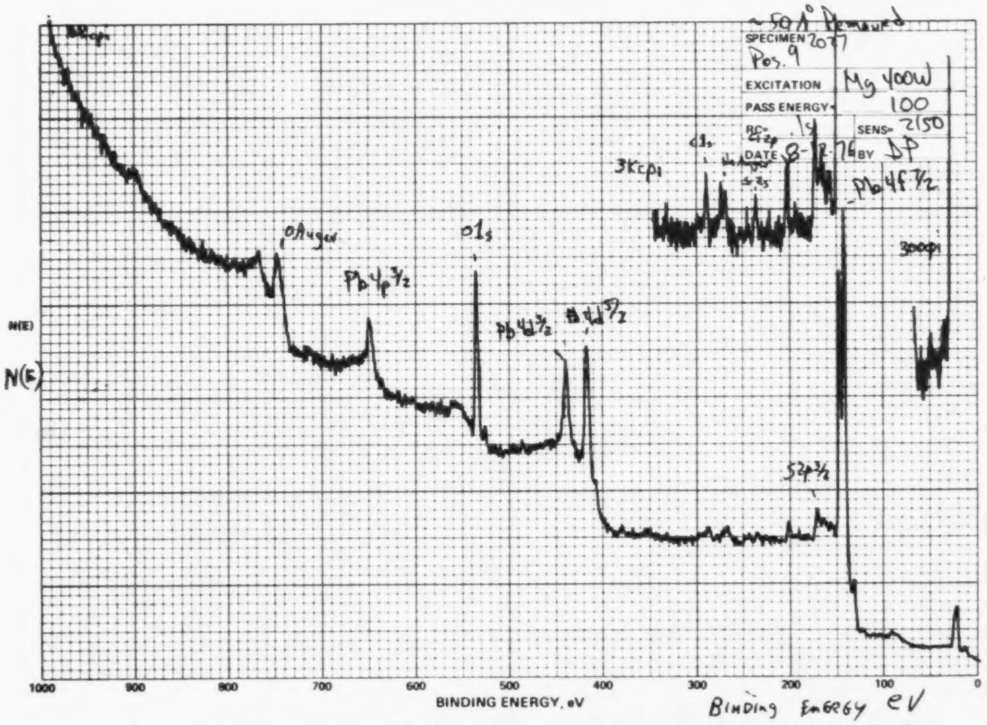
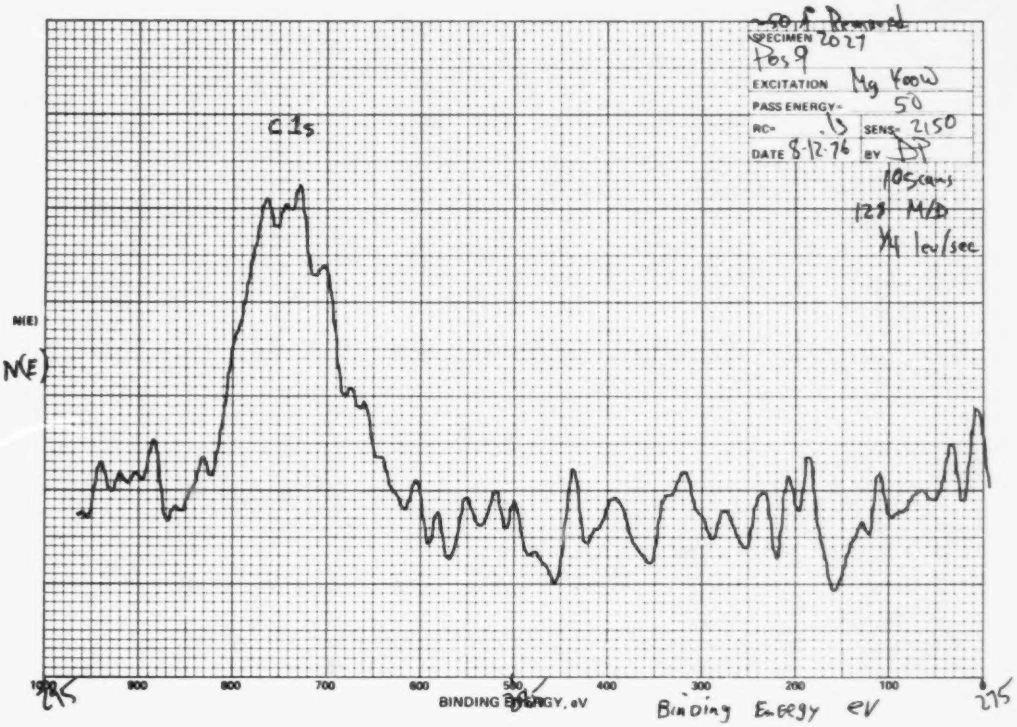


Figure F-10 - ESCA Graph - Run 5, Location 2N, Filter 2027



~50 Å Removed

SPECIMEN 2027 Pos 9

EXCITATION Mg 400W

PASS ENERGY= 50

RC= .13 SENS= 2150

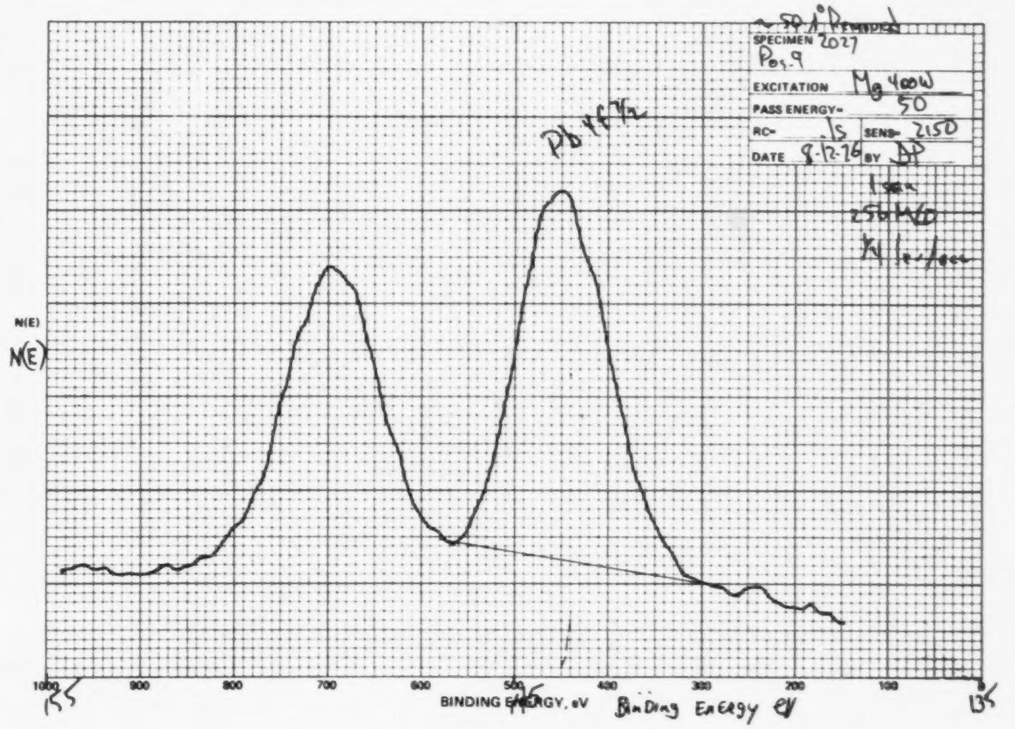
DATE 8-12-76 BY DP

10 scans

128 M/D

1/4 lev/sec

Figure F-11 - ESCA Graph - Run 5, Location 2N, Filter 2027



~50 Å Removed

SPECIMEN 2027 Pos. 9

EXCITATION Mg 400W

PASS ENERGY= 50

RC= .1S SENS= 2150

DATE 8-12-76 BY DP

1 scan

256 M/D

1/4 lev/sec

Figure F-12 - ESCA Graph - Run 5, Location 2N, Filter 2027

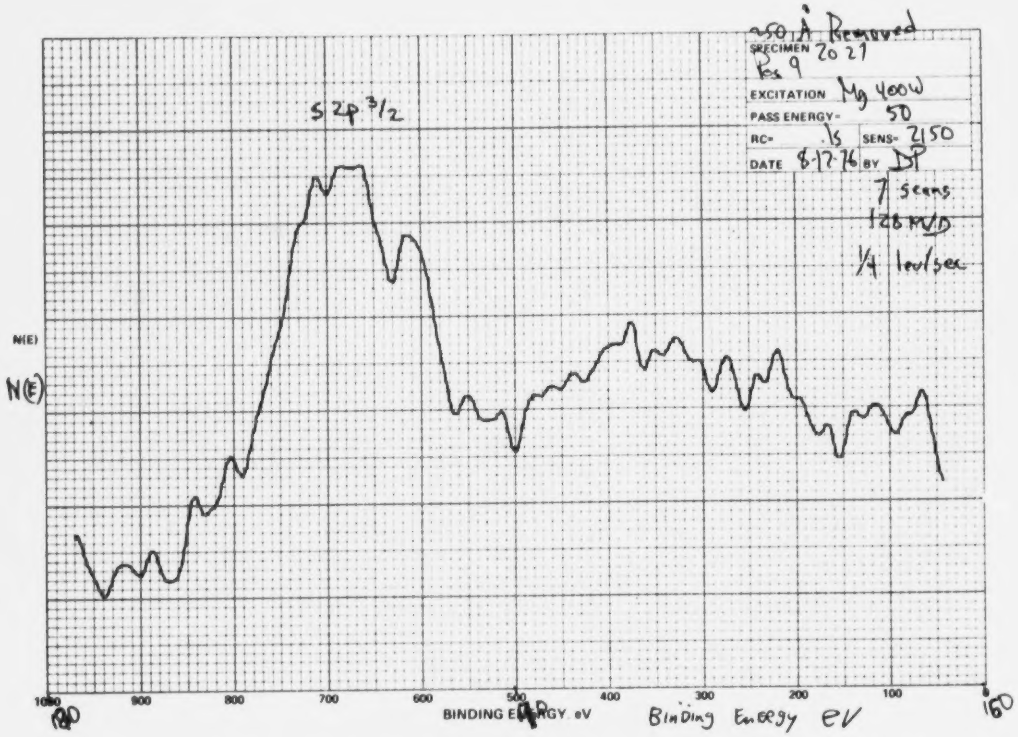


Figure F-13 - ESCA Graph - Run 5, Location 2N, Filter 2027

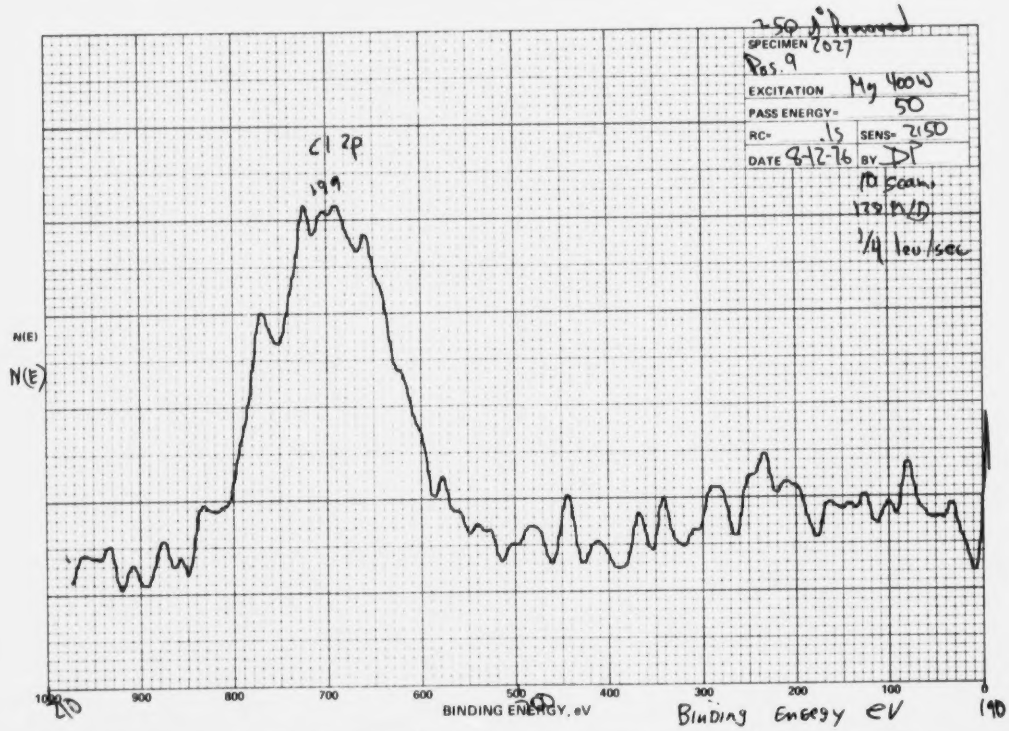


Figure F-14 - ESCA Graph - Run 5, Location 2N, Filter 2027

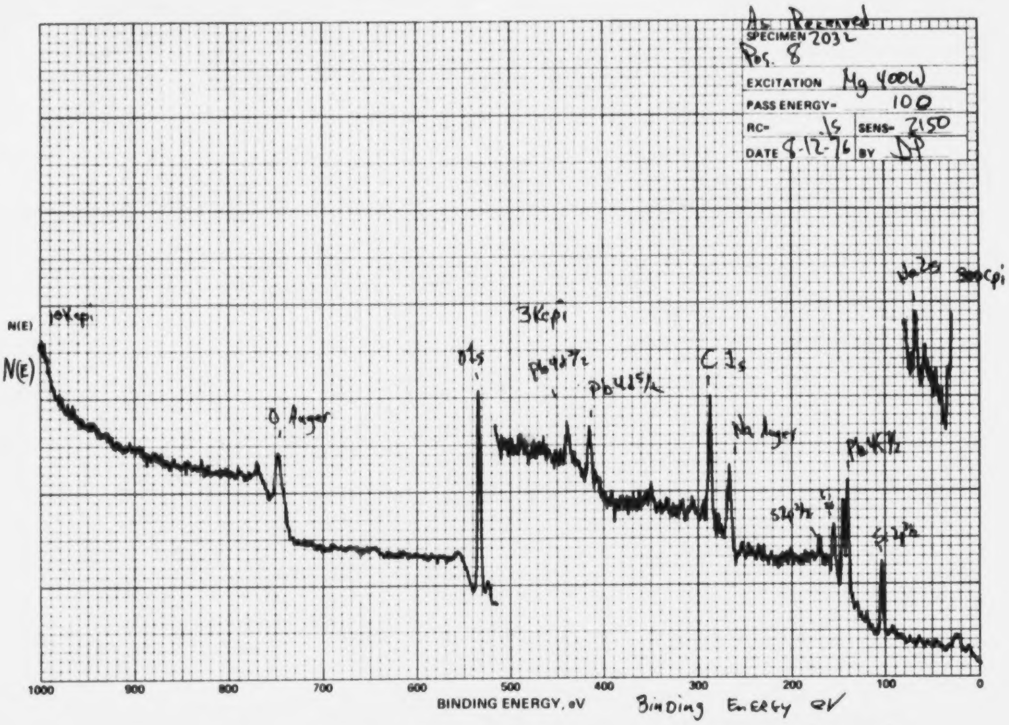


Figure F-15 - ESCA Graph - Run 5, Location 1B, Filter 2032

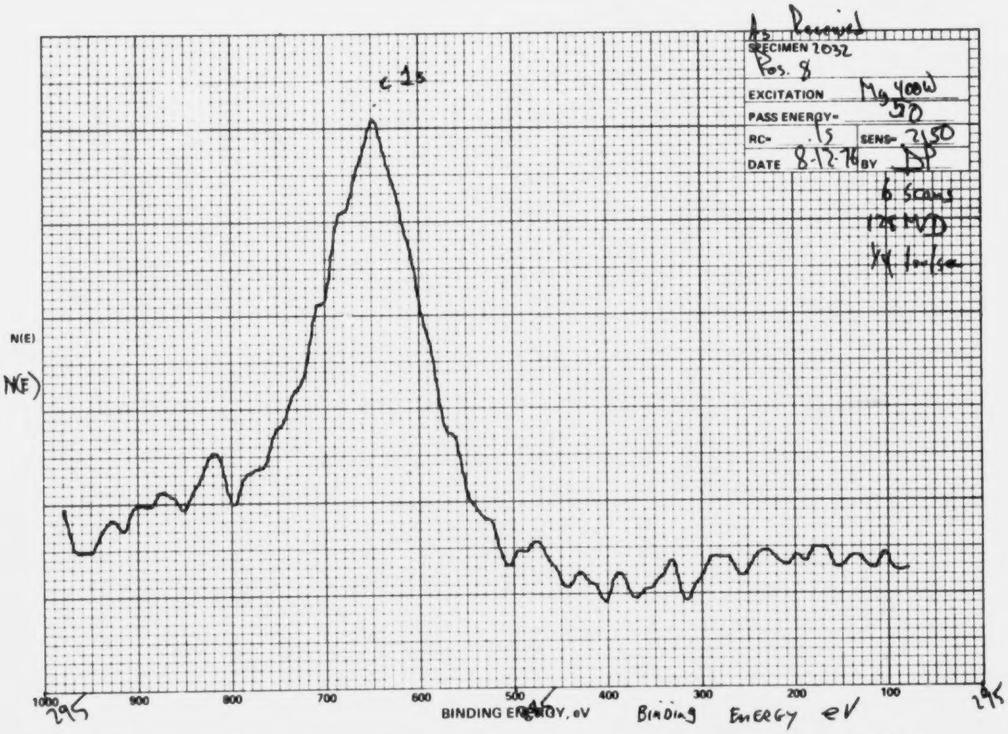


Figure F-16 - ESCA Graph - Run 5, Location 1B, Filter 2032

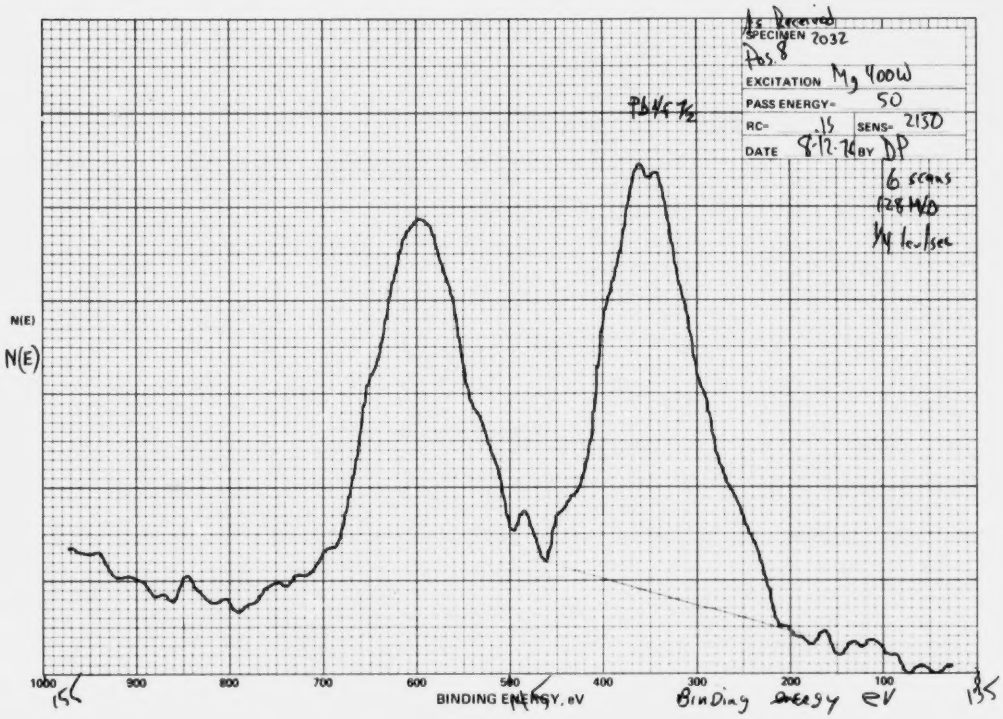


Figure F-17 - ESCA Graph - Run 5, Location 1B, Filter 2032

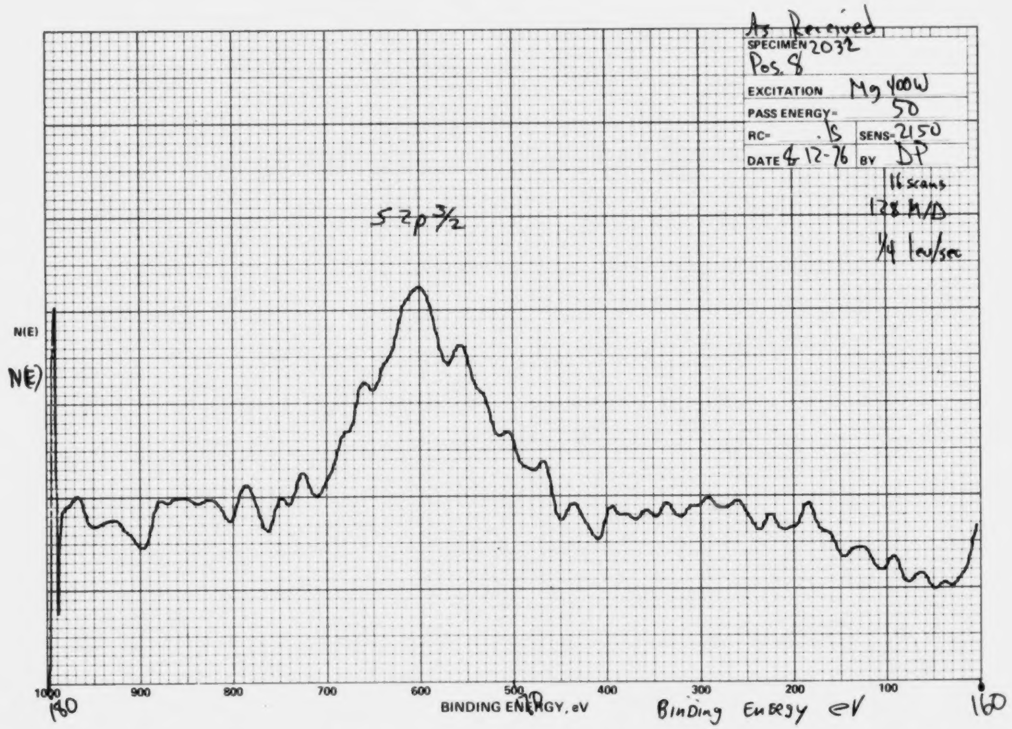


Figure F-18 - ESCA Graph - Run 5, Location 1B, Filter 2032

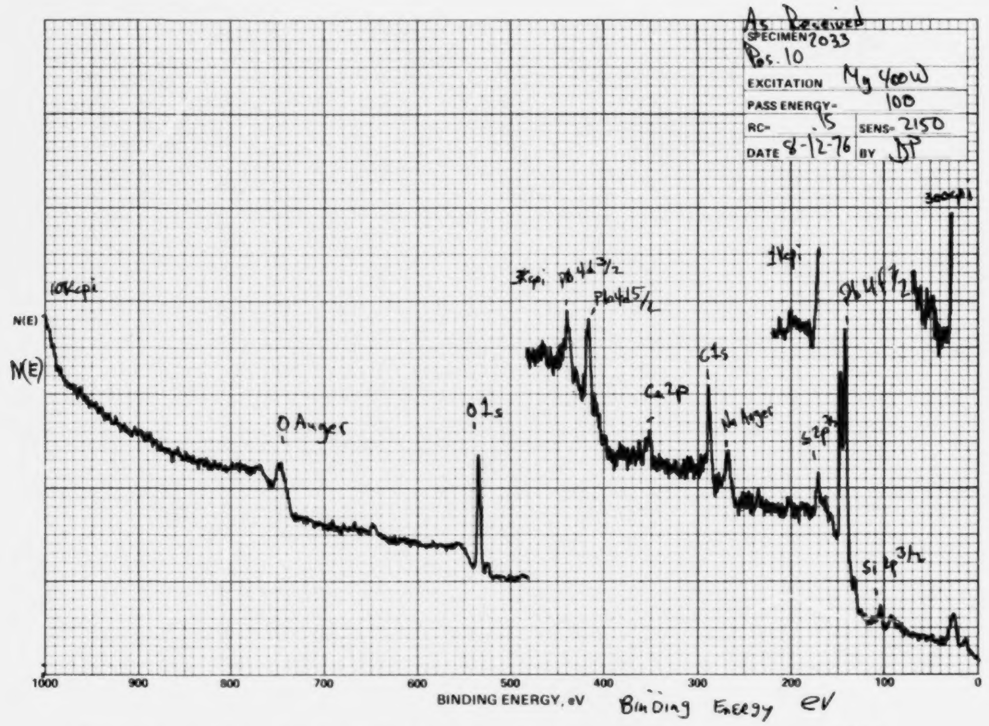


Figure F-19 - ESCA Graph - Run 5, Location 3, Filter 2033

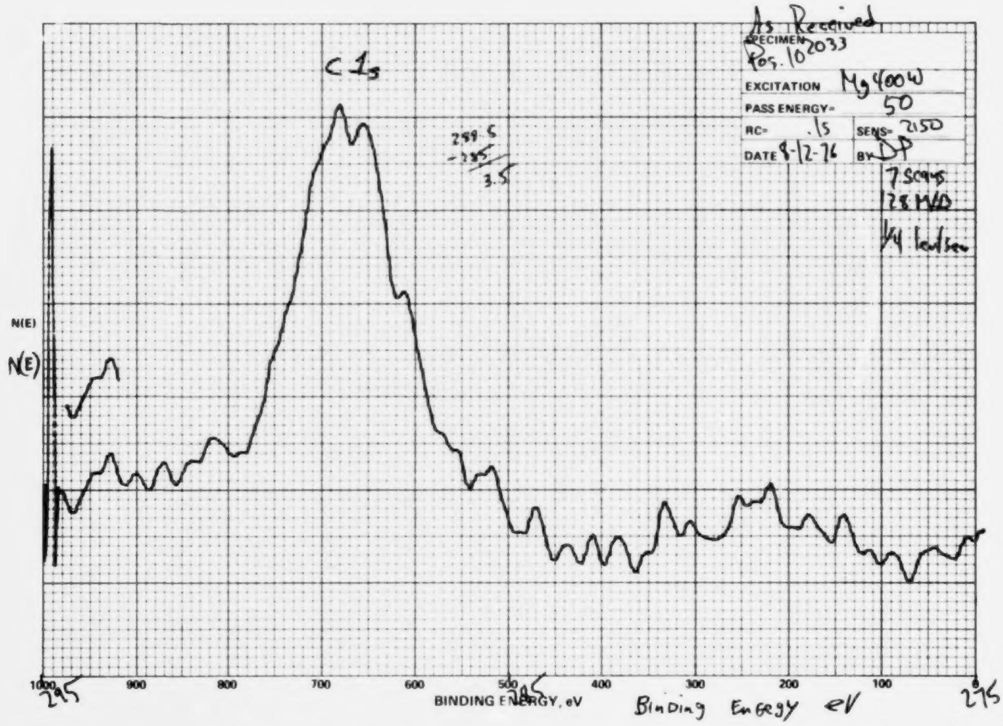


Figure F-20 - ESCA Graph - Run 5, Location 3, Filter 2033

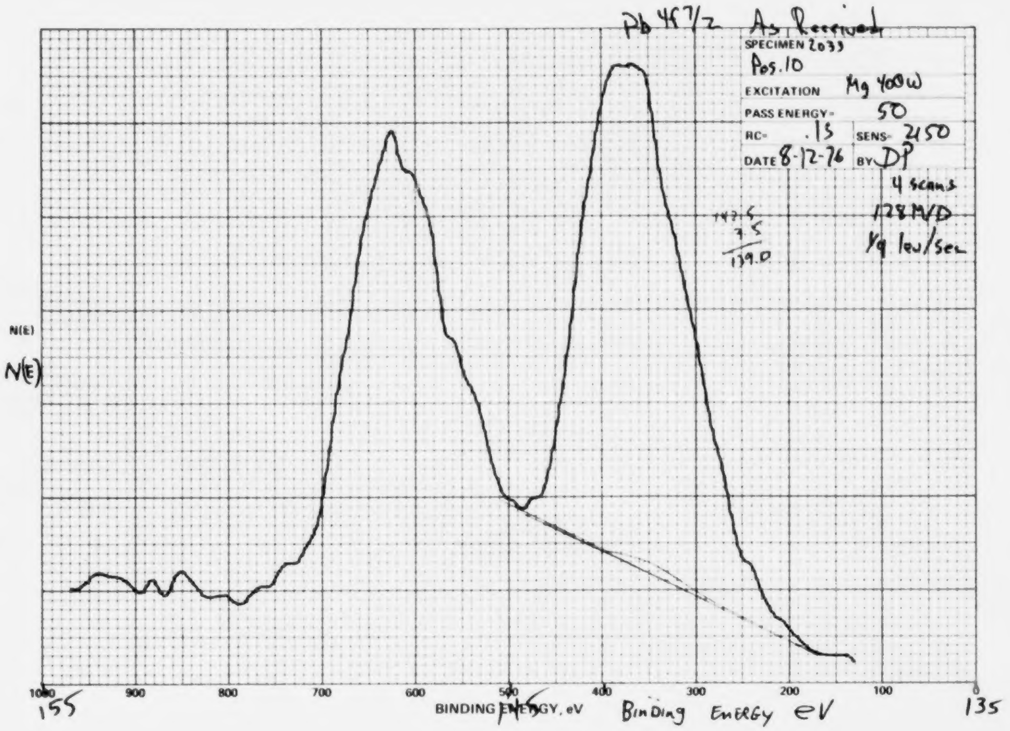


Figure F-21 - ESCA Graph - Run 5, Location 3, Filter 2033

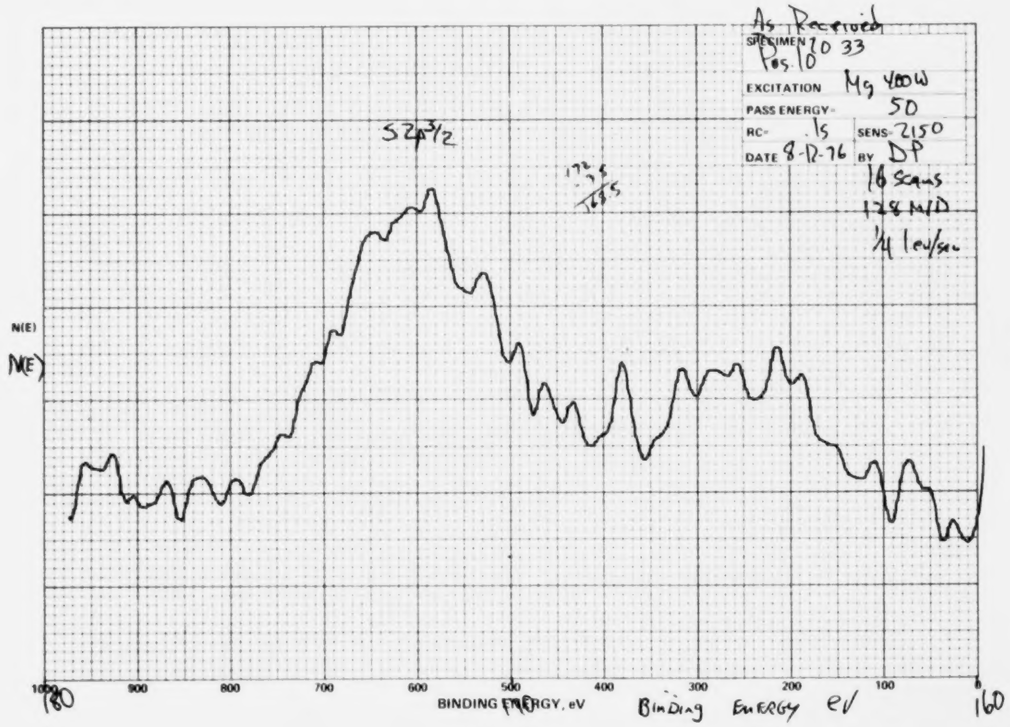


Figure F-22 - ESCA Graph - Run 5, Location 3, Filter 2033

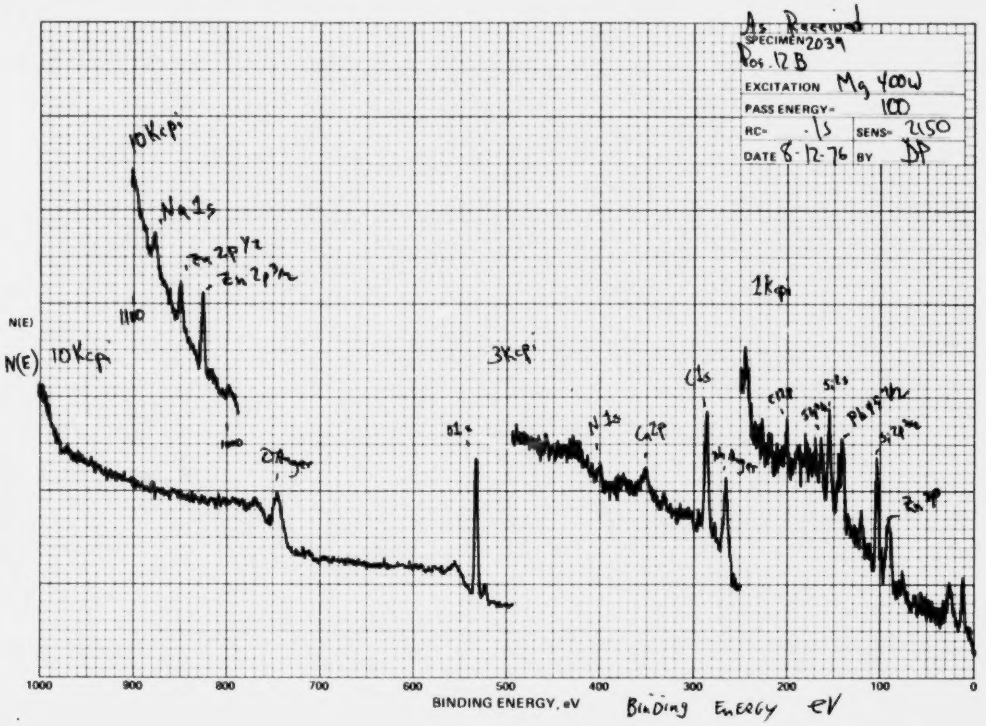


Figure F-23 - ESCA Graph - Run 8, Location 6S, Filter 2039

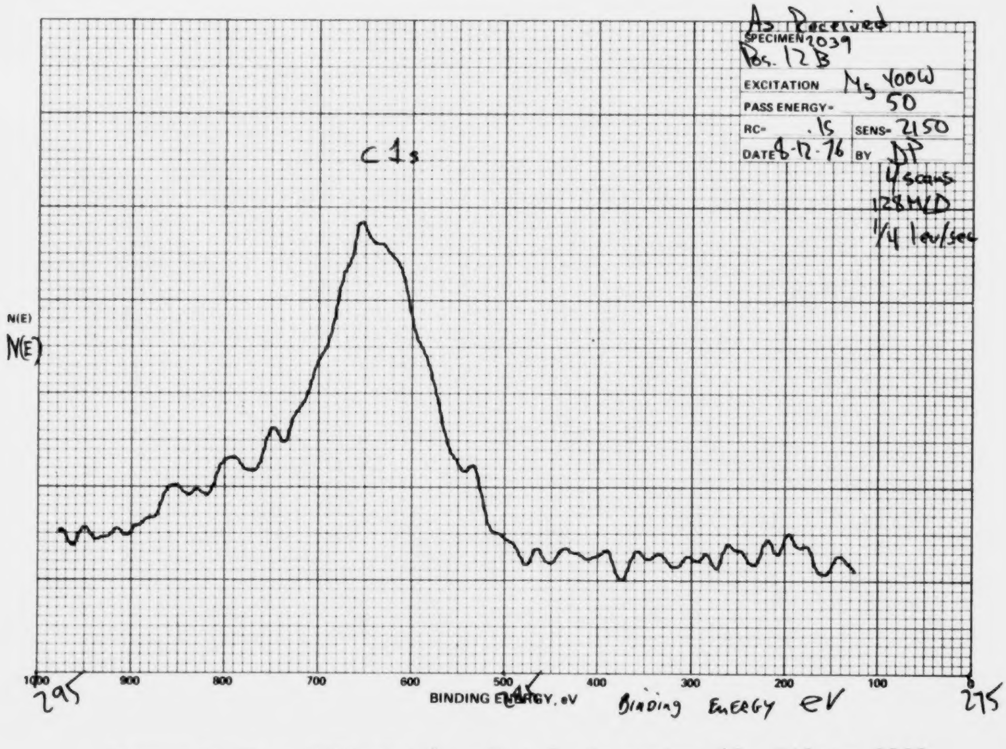


Figure F-24 - ESCA Graph - Run 8, Location 6S, Filter 2039

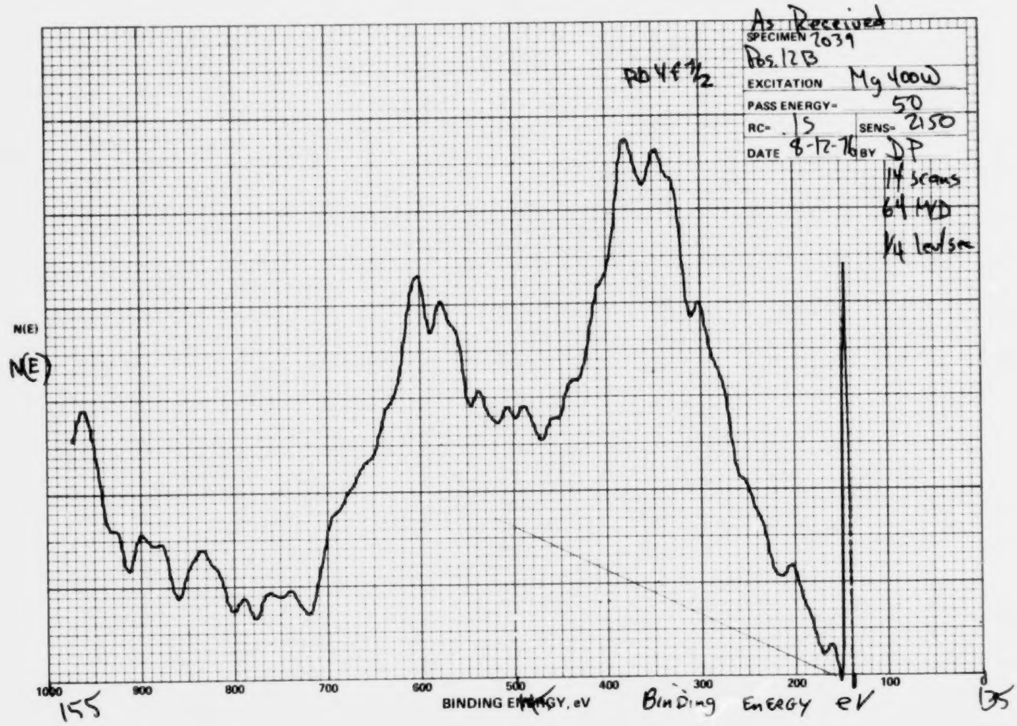


Figure F-25 - ESCA Graph - Run 8, Location 6S, Filter 2039

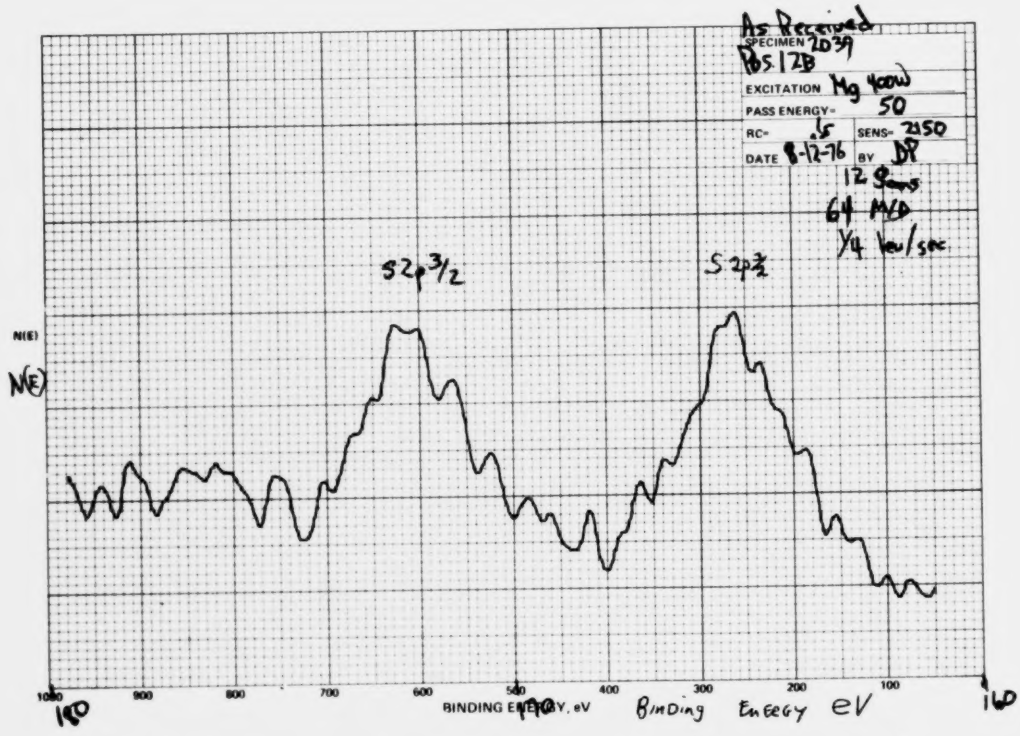


Figure F-26 - ESCA Graph - Run 8, Location 6S, Filter 2039

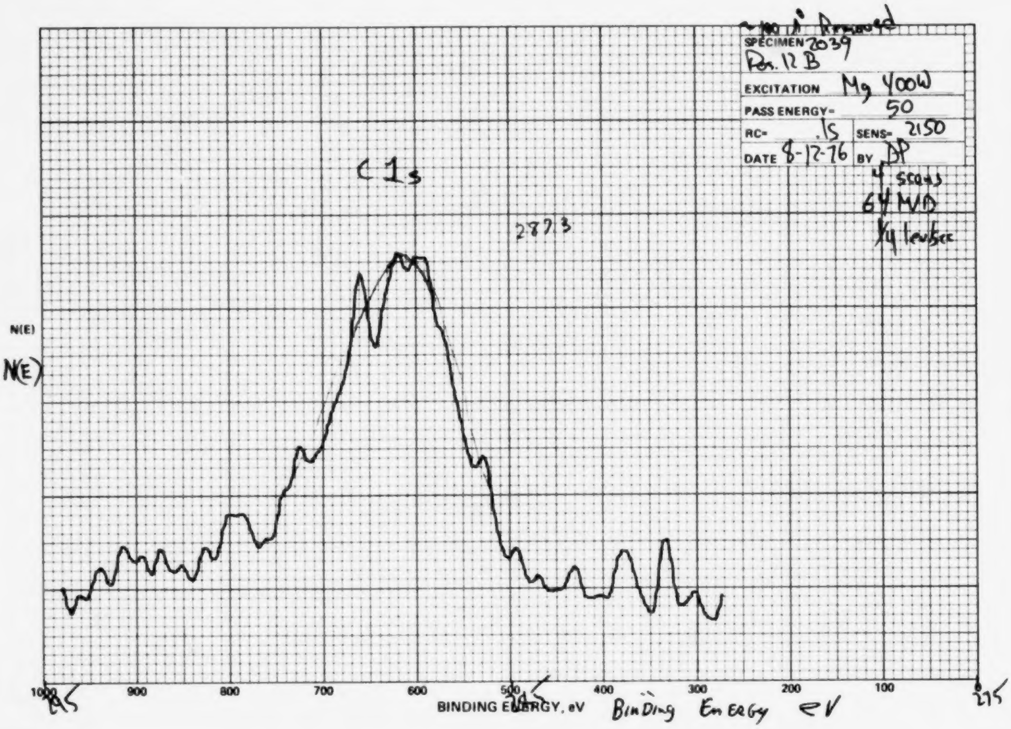


Figure F-27 - ESCA Graph - Run 8, Location 6S, Filter 2039

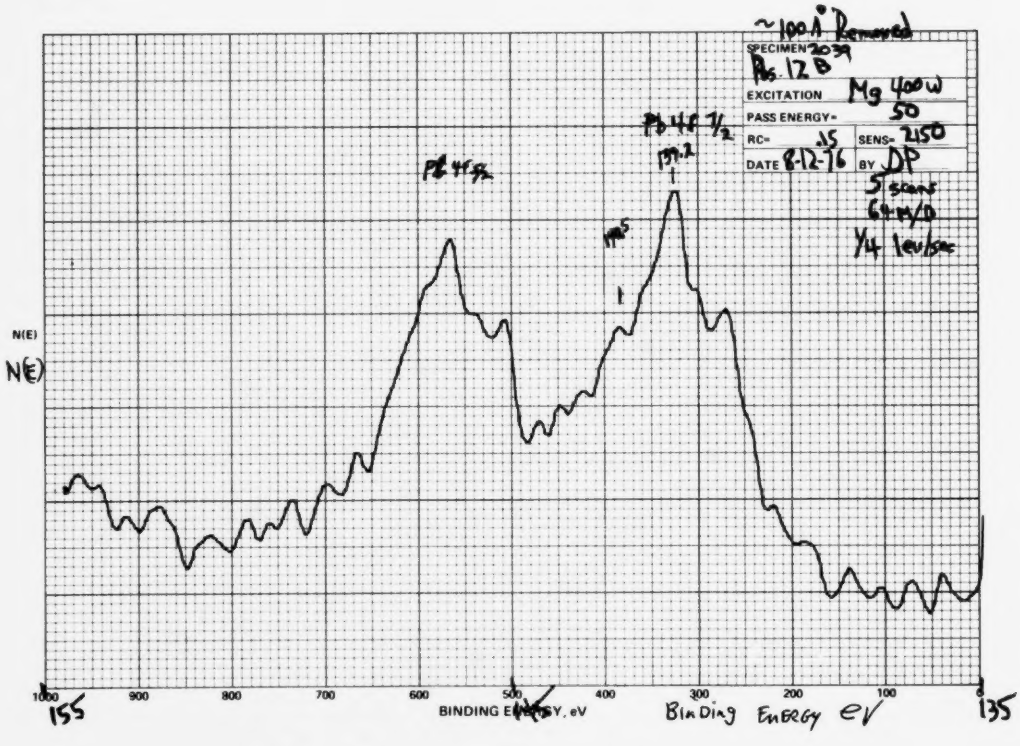


Figure F-28 - ESCA Graph - Run 8, Location 6S, Filter 2039

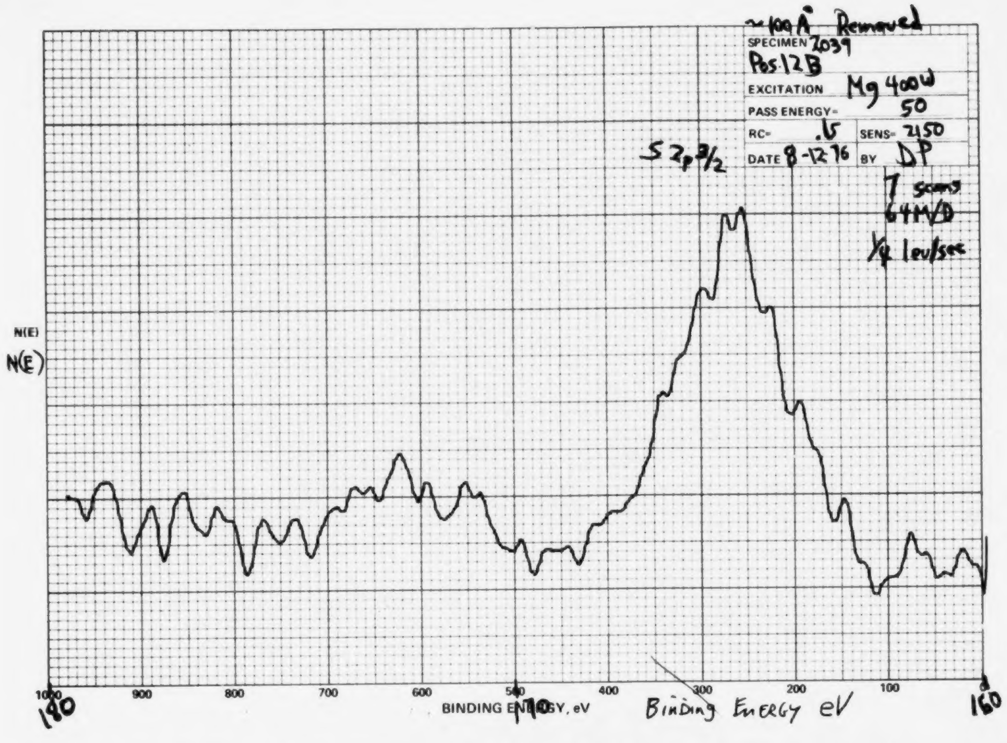


Figure F-29 - ESCA Graph - Run 8, Location 6S, Filter 2039

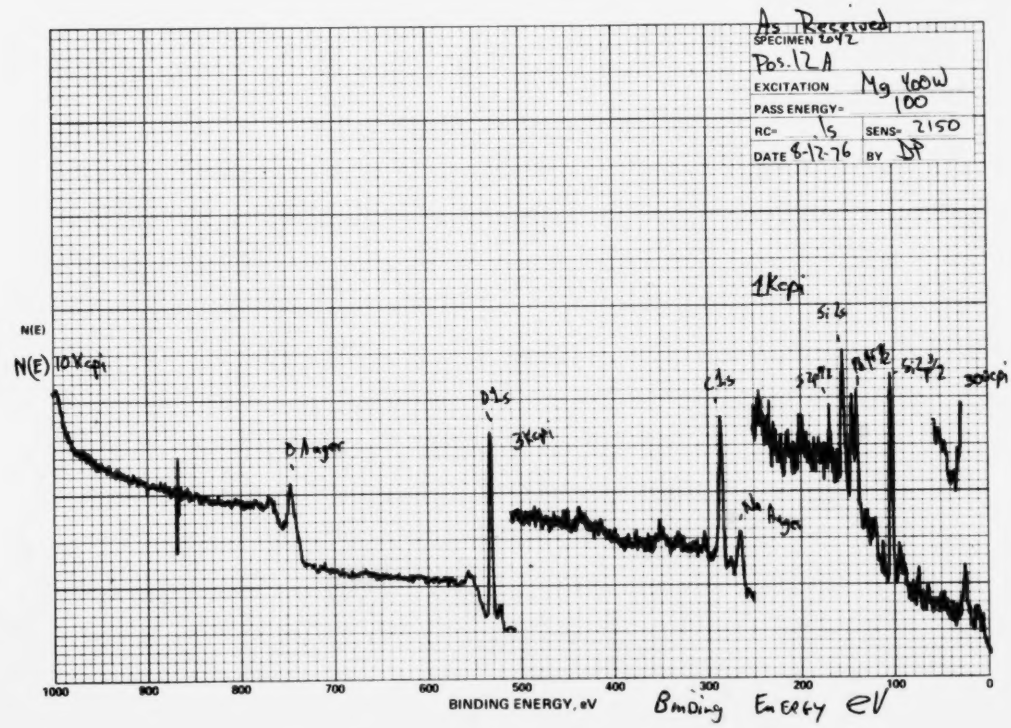


Figure F-30 - ESCA Graph - Run 8, Location 5, Filter 2042

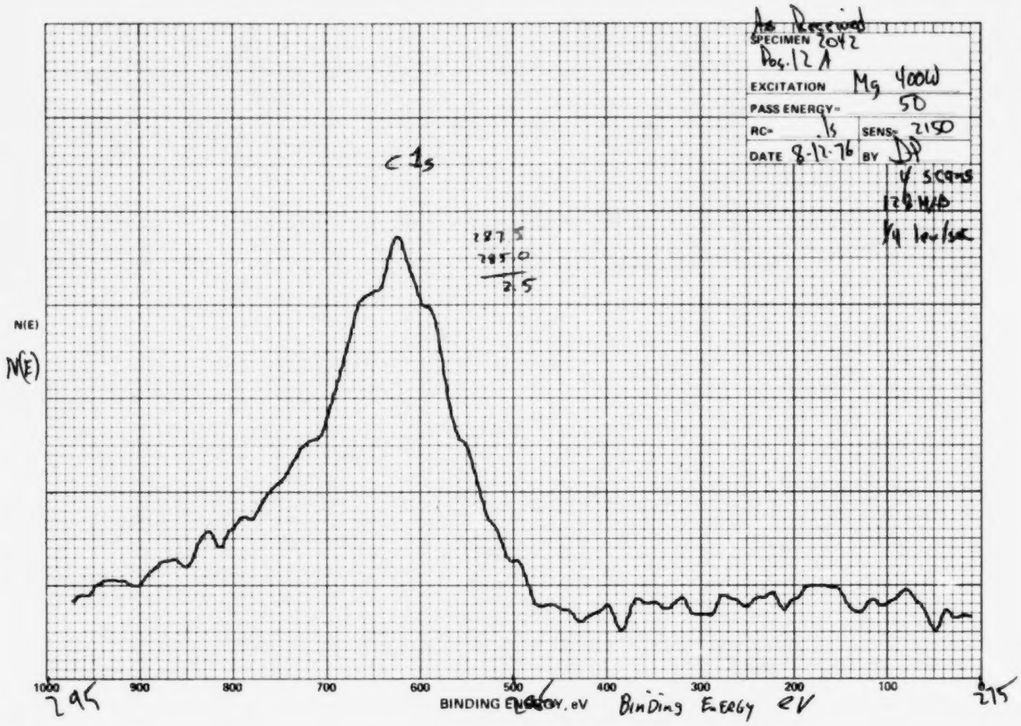


Figure F-31 - ESCA Graph - Run 8, Location 5, Filter 2042

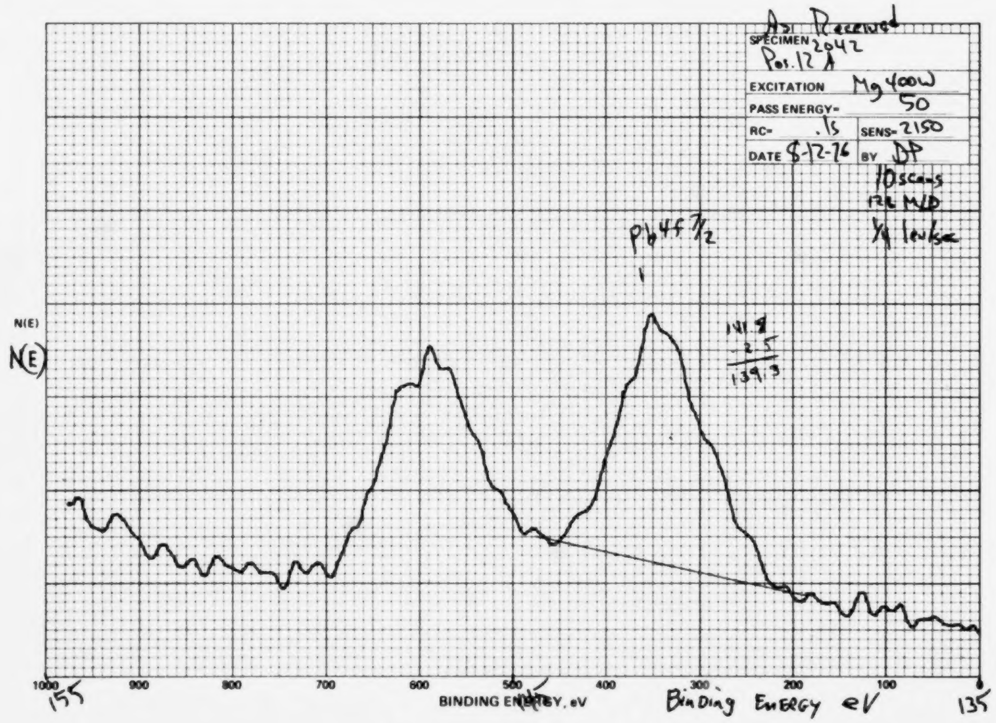


Figure F-32 - ESCA Graph - Run 8, Location 5, Filter 2042

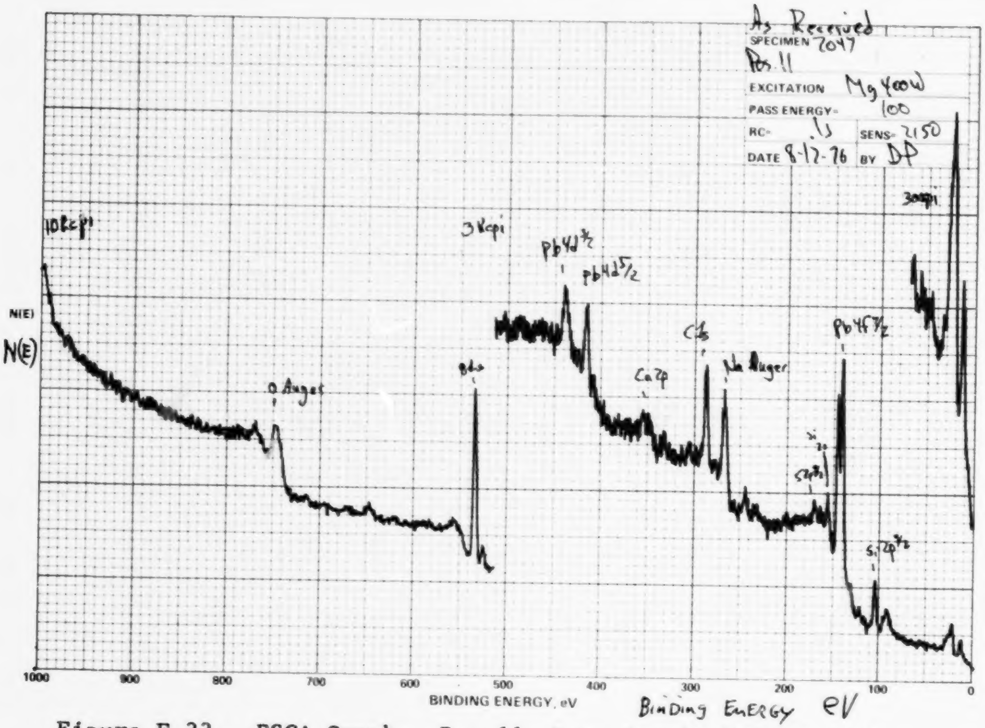


Figure F-33 - ESCA Graph - Run 11, Location 4, Filter 2047

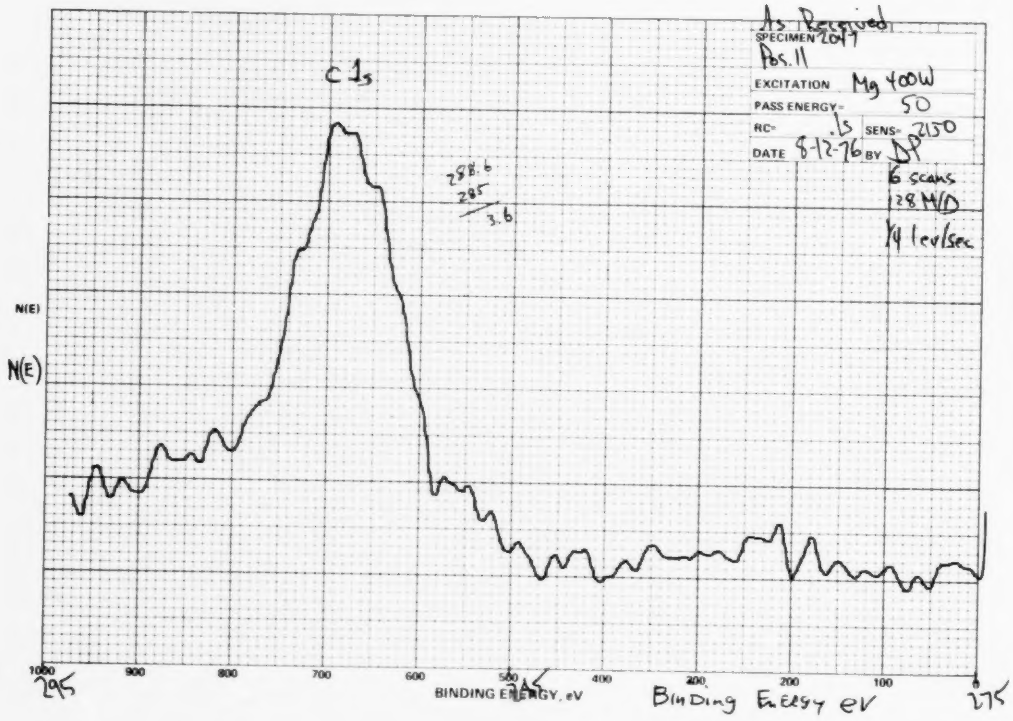


Figure F-34 - ESCA Graph - Run 11, Location 4, Filter 2047

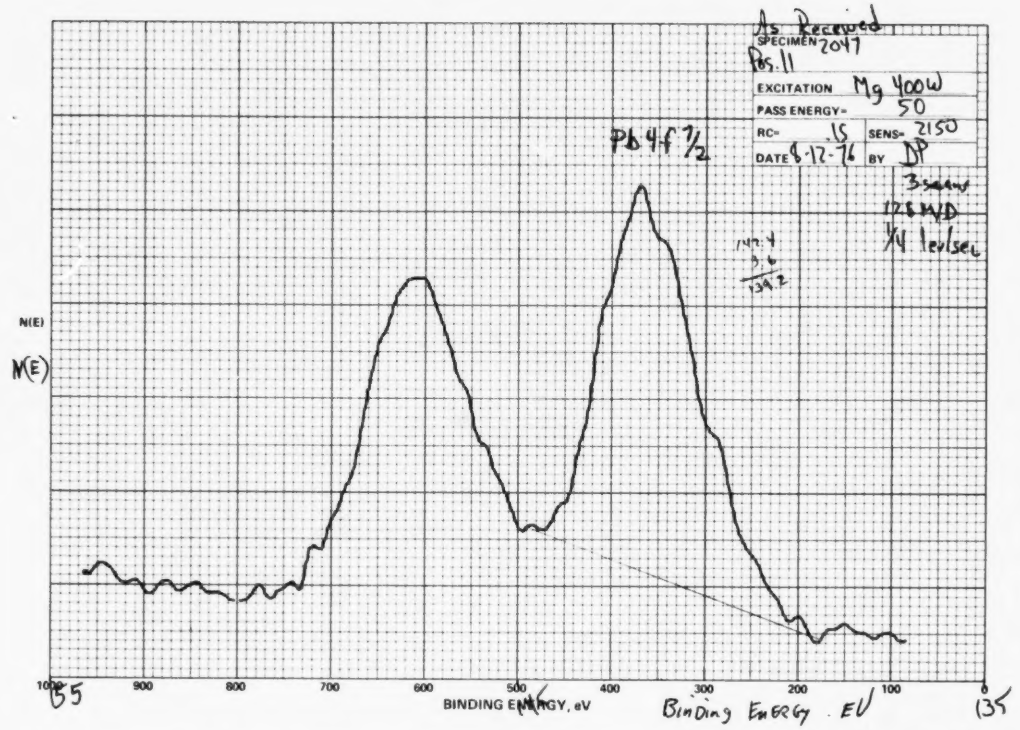


Figure F-35 - ESCA Graph - Run 11, Location 4, Filter 2047

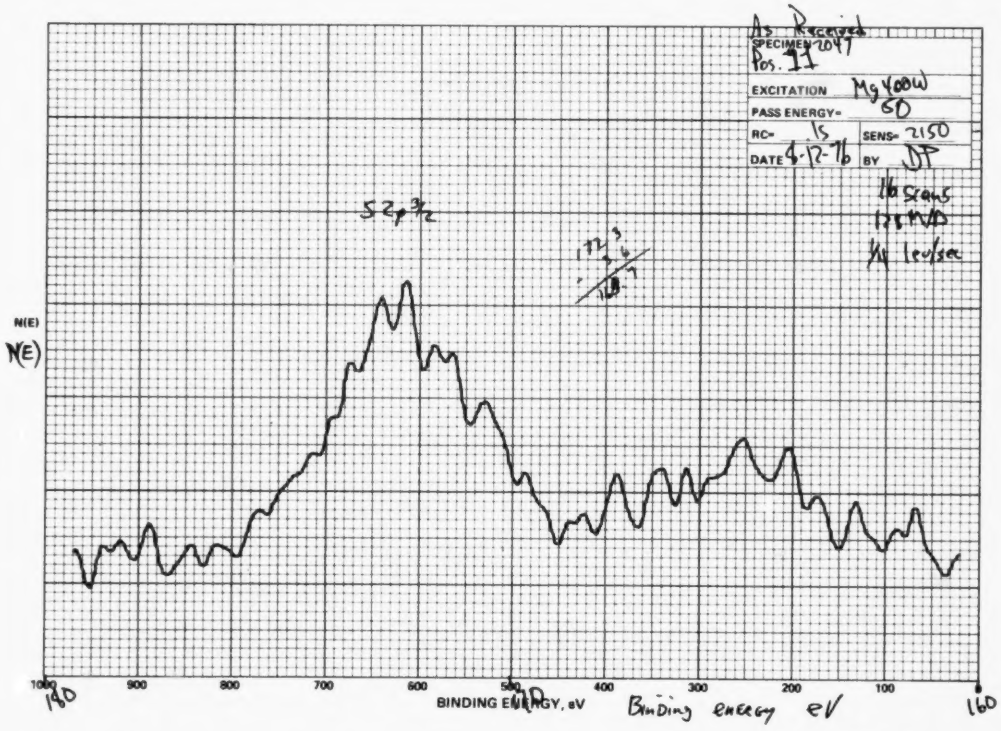


Figure F-36 - ESCA Graph - Run 11, Location 4, Filter 2047

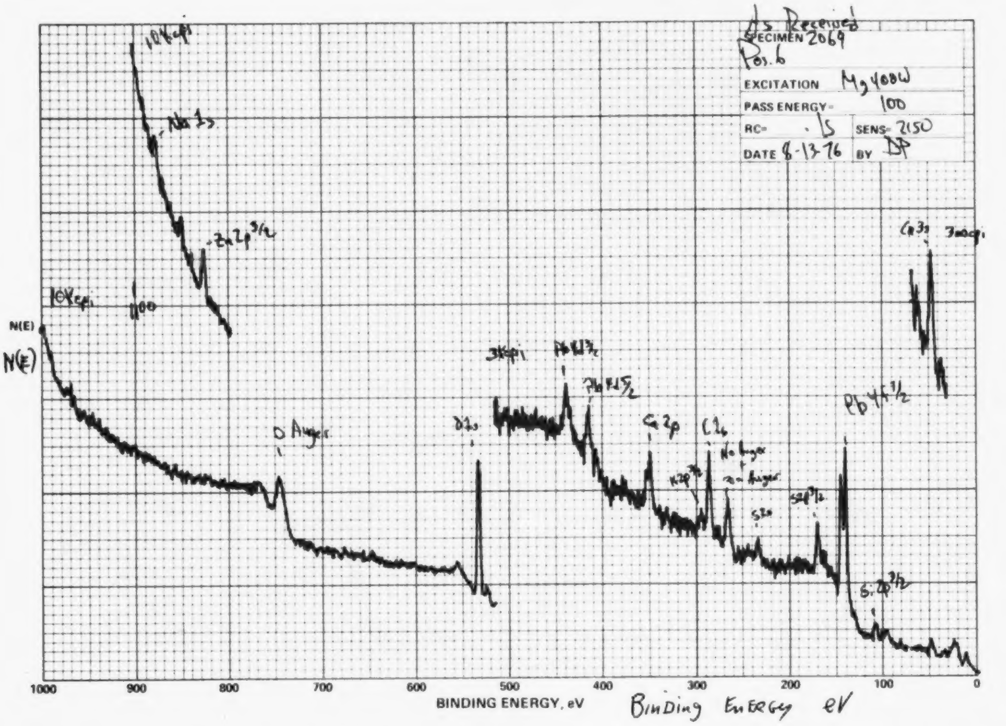


Figure F-37 - ESCA Graph - Run 21, Location 11, Sierra Backup, Filter 2069

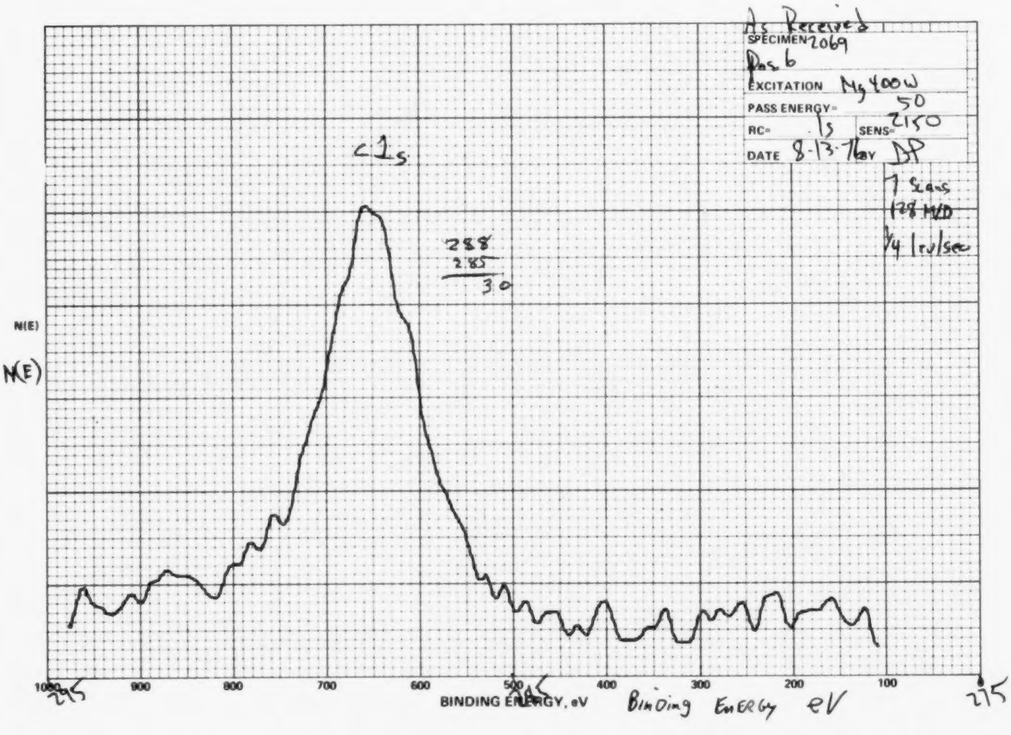


Figure F-38 - ESCA Graph - Run 21, Location 11, Sierra Backup, Filter 2069

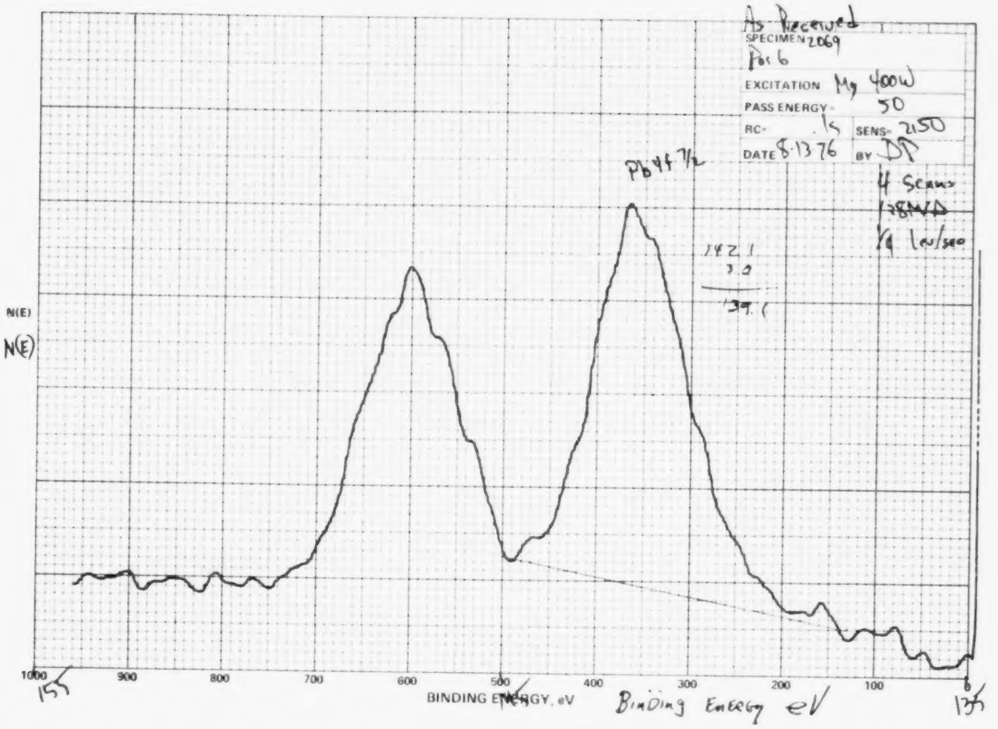


Figure F-39 - ESCA Graph - Run 21, Location 11, Sierra Backup, Filter 2069

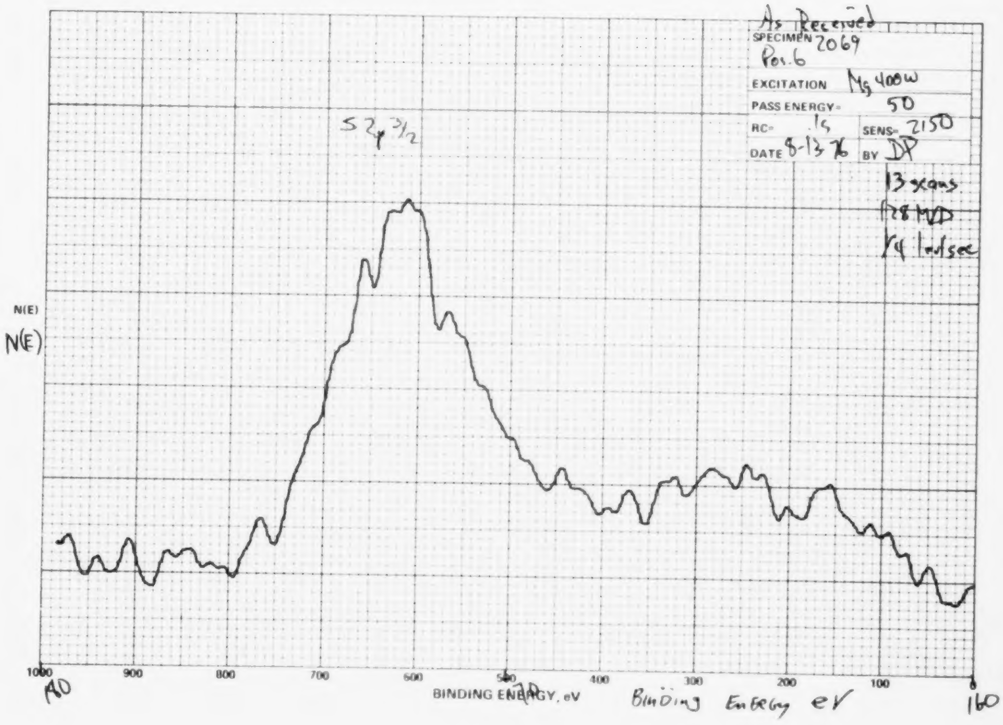
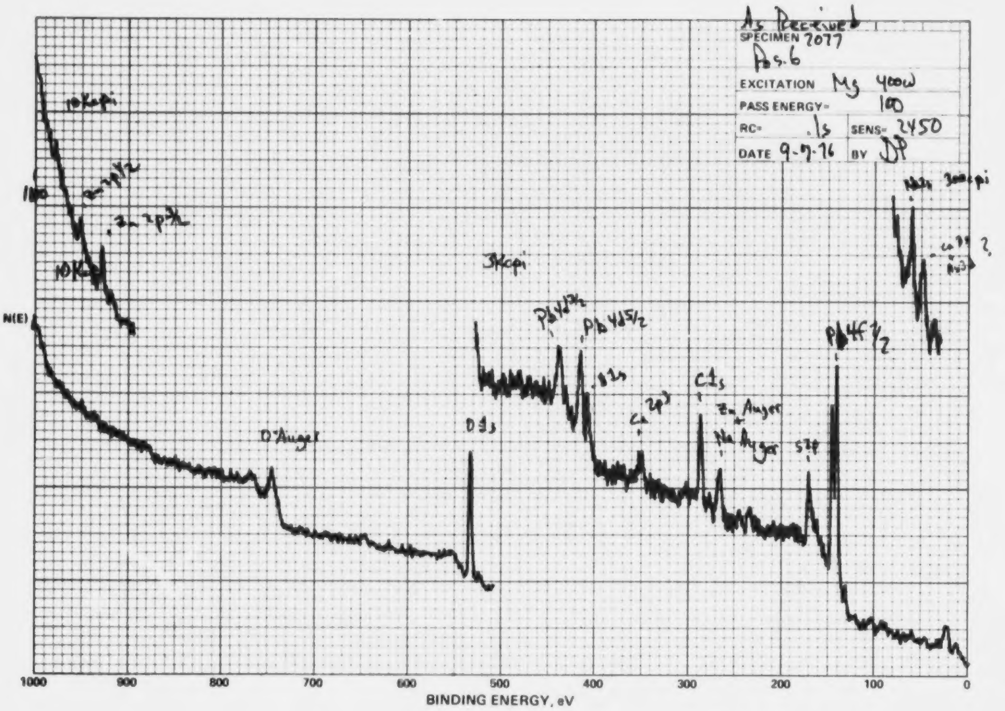


Figure F-40 - ESCA Graph - Run 21, Location 11, Sierra Backup, Filter 2069



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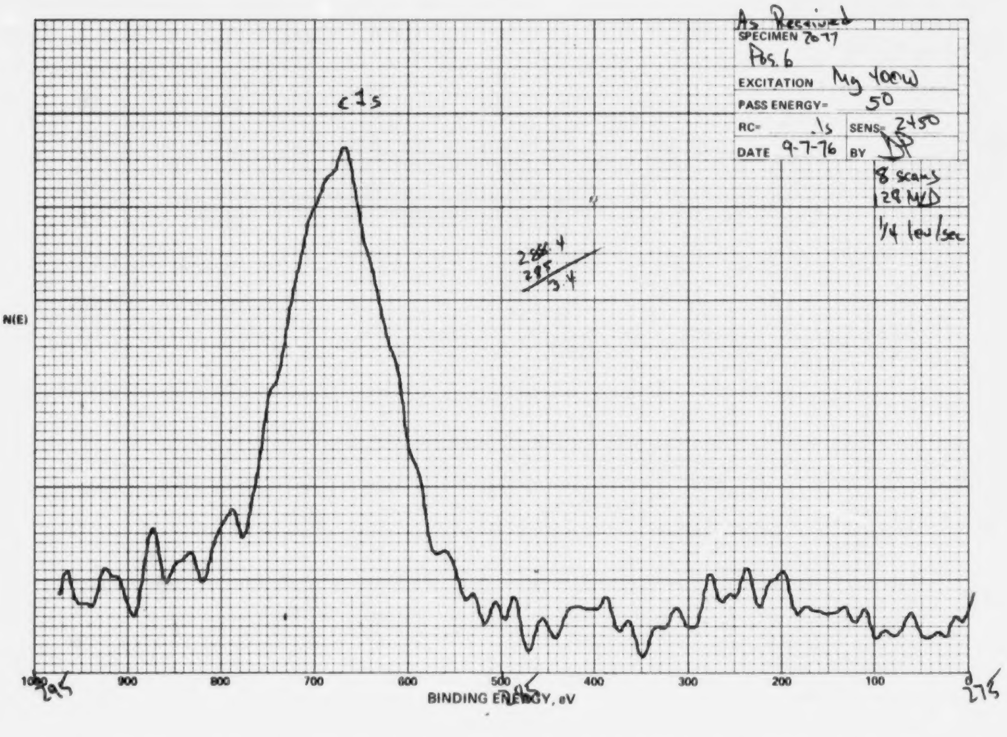
BY DP

Figure F-41 - ESCA Graph - Run 22, Location 11, Filter 2077



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1/4 1ev/sec

Figure F-42 - ESCA Graph - Run 22, Location 11, Filter 2077

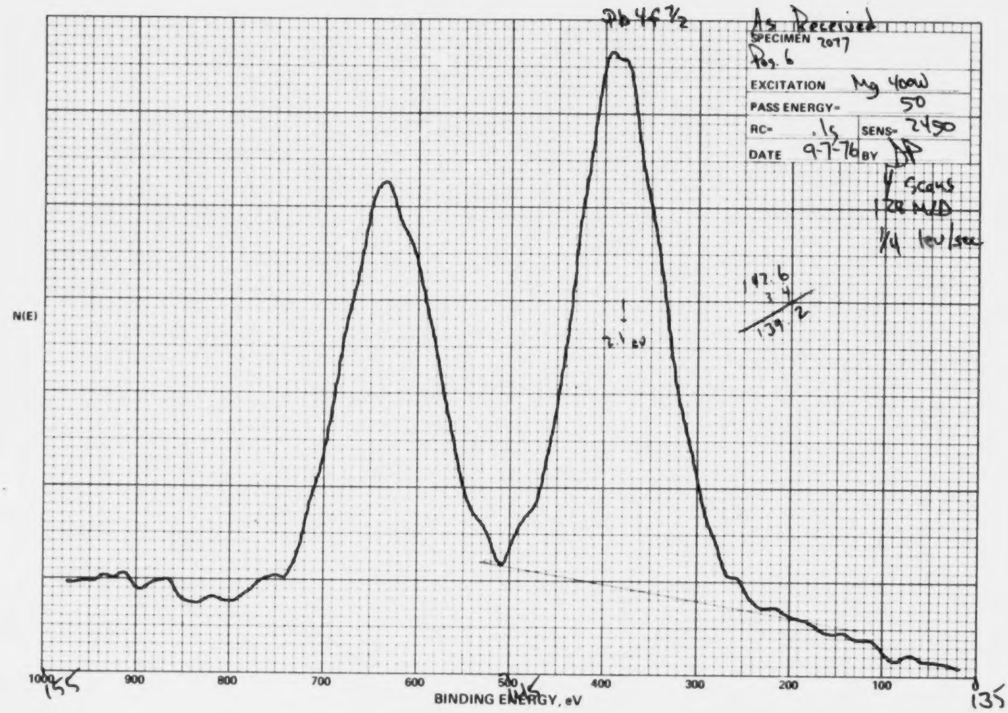


Figure F-43 - ESCA Graph - Run 22, Location 11, Filter 2077

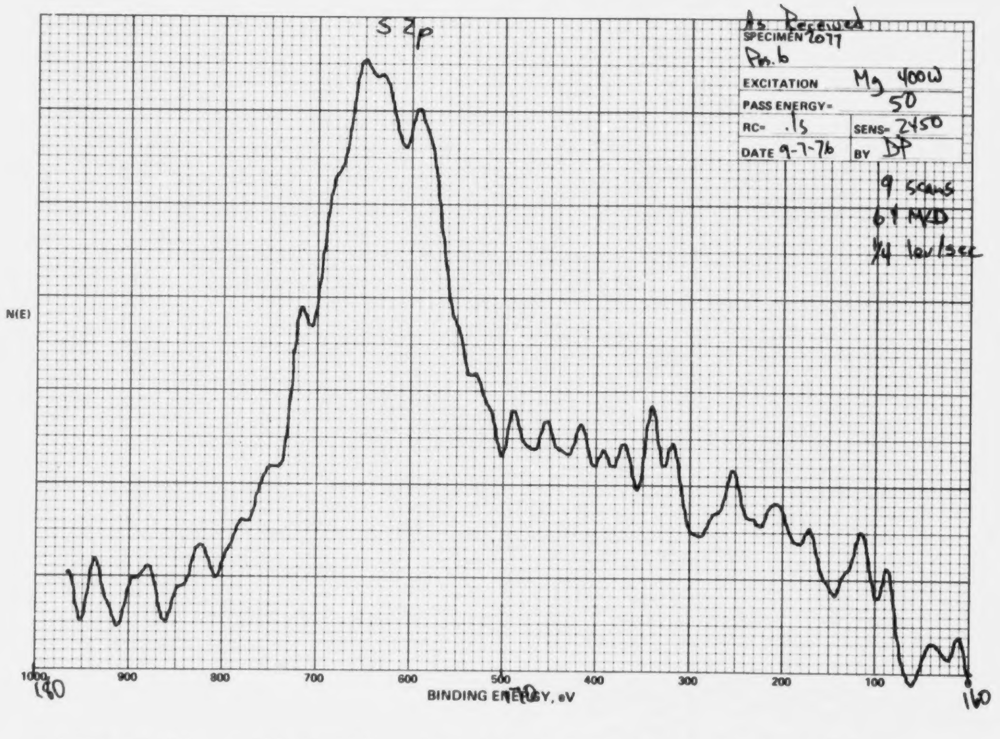


Figure F-44 - ESCA Graph - Run 22, Location 11, Filter 2077

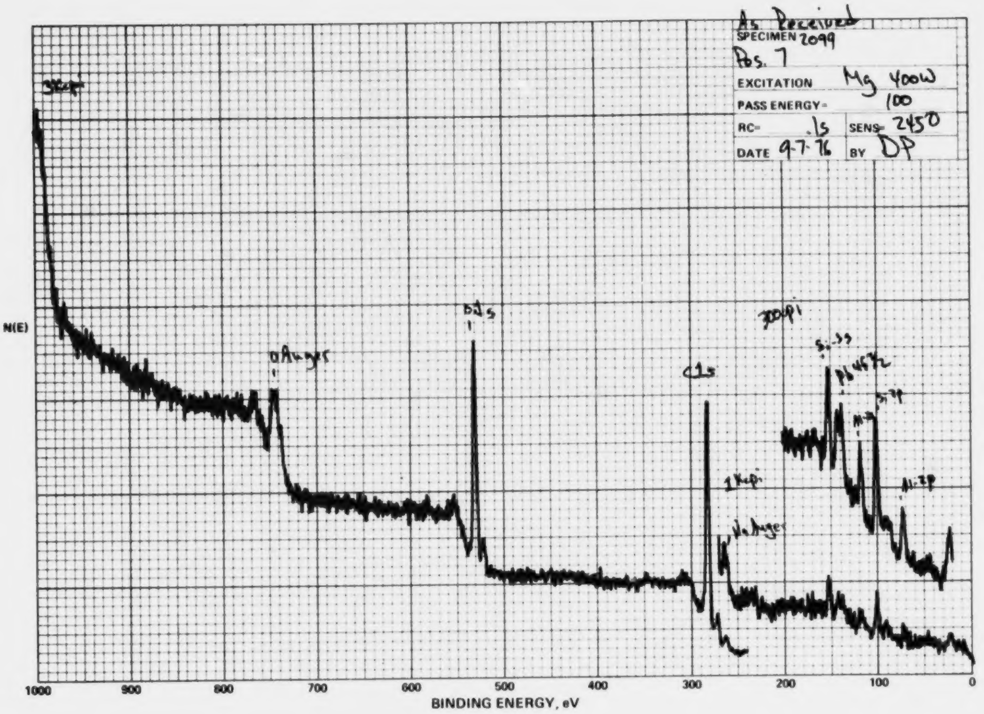


Figure F-45 - ESCA Graph - Run 25, Location 23A, Filter 2099

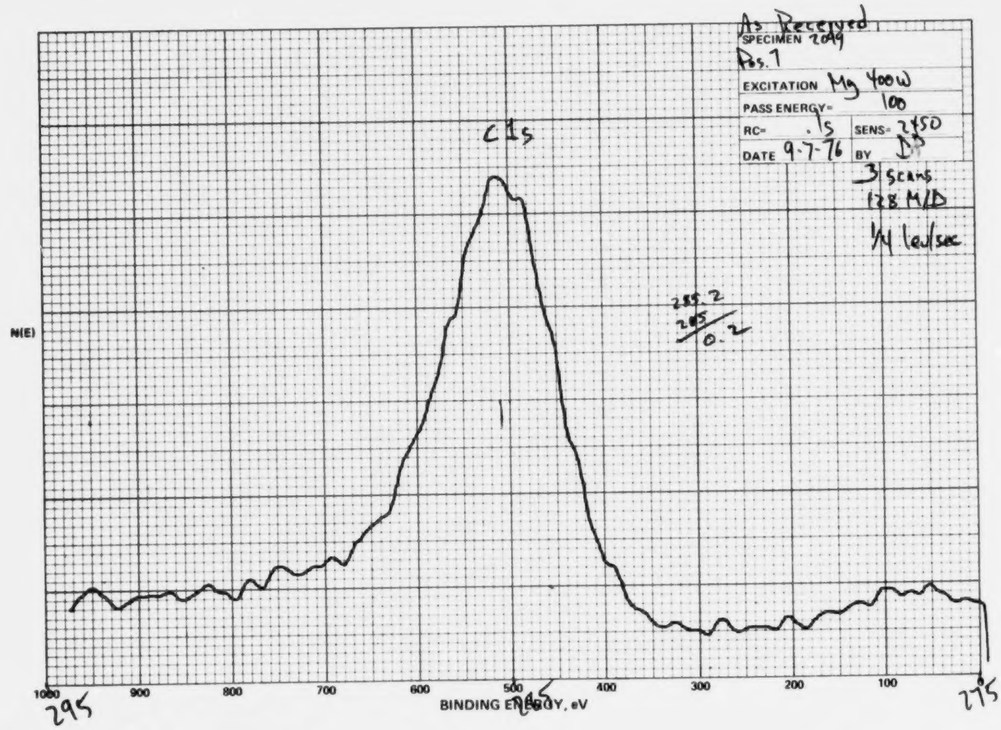


Figure F-46 - ESCA Graph - Run 25, Location 23A, Filter 2099

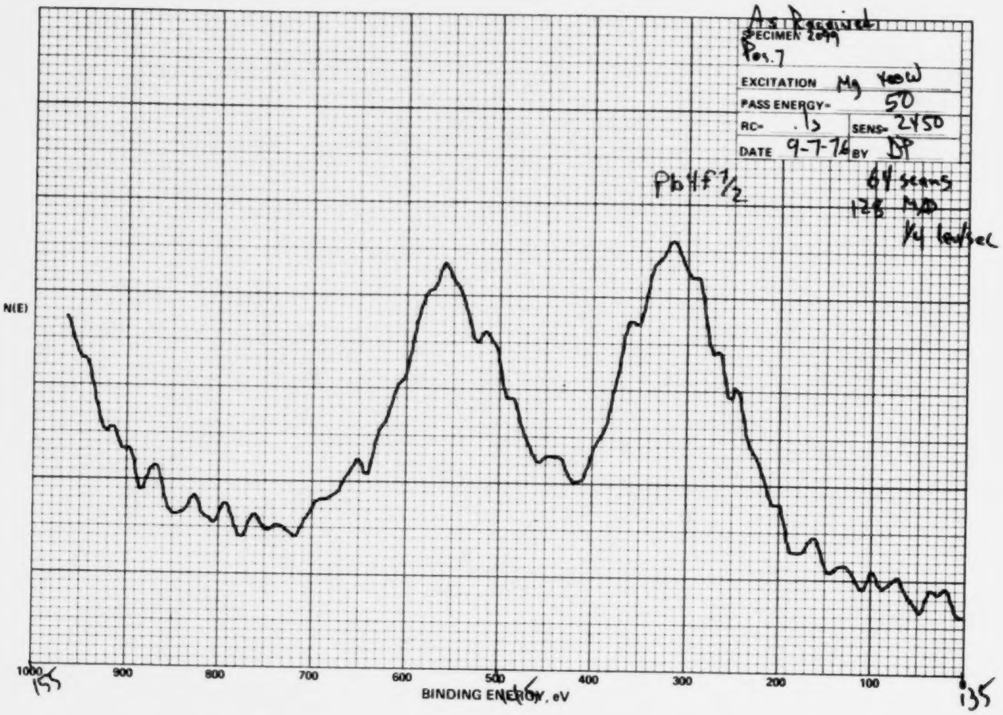


Figure F-47 - ESCA Graph - Run 25, Location 23A, Filter 2099

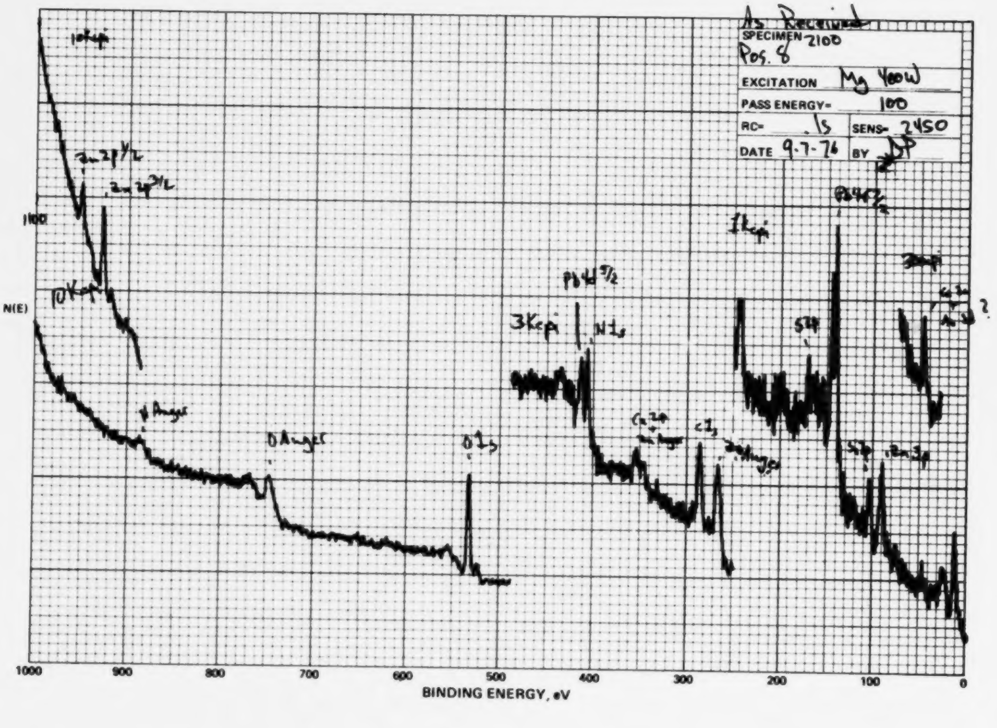
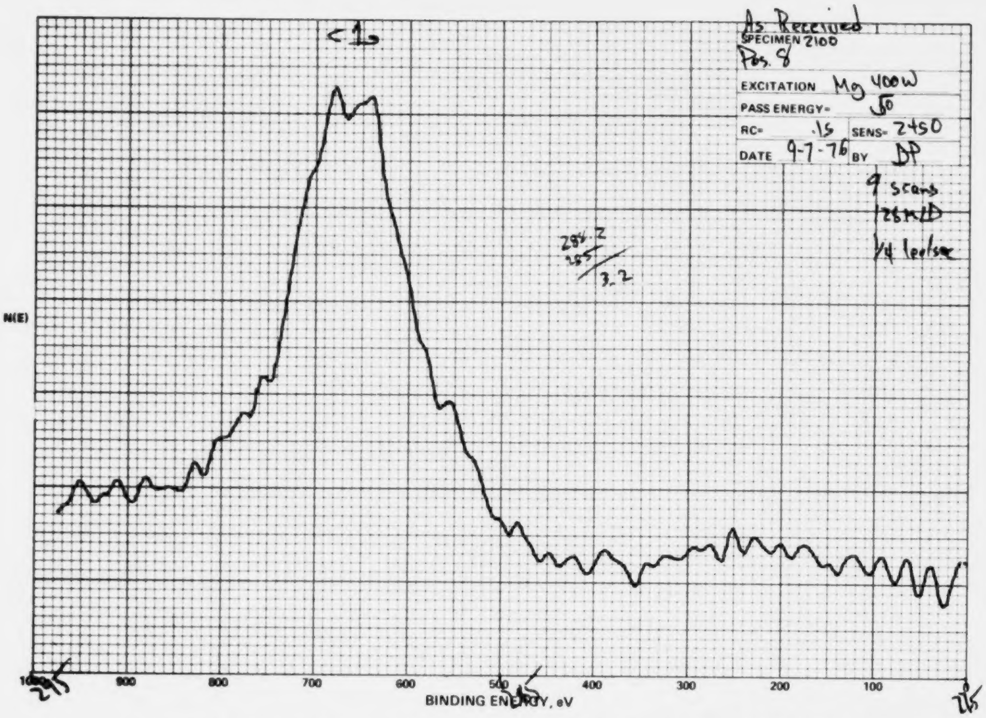


Figure F-48 - ESCA Graph - Run 25, Location 24N, Filter 2100



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9 scans
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1/4 fee/sec

Figure F-49 - ESCA Graph - Run 25, Location 24N, Filter 2100

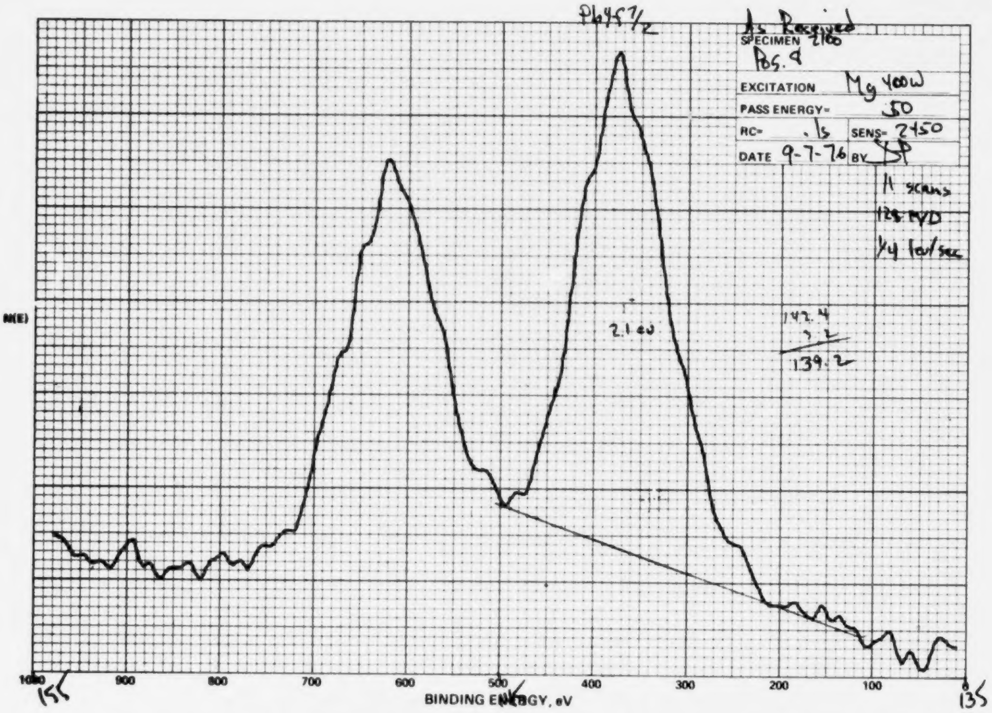

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Figure F-50 - ESCA Graph - Run 25, Location 24N, Filter 2100

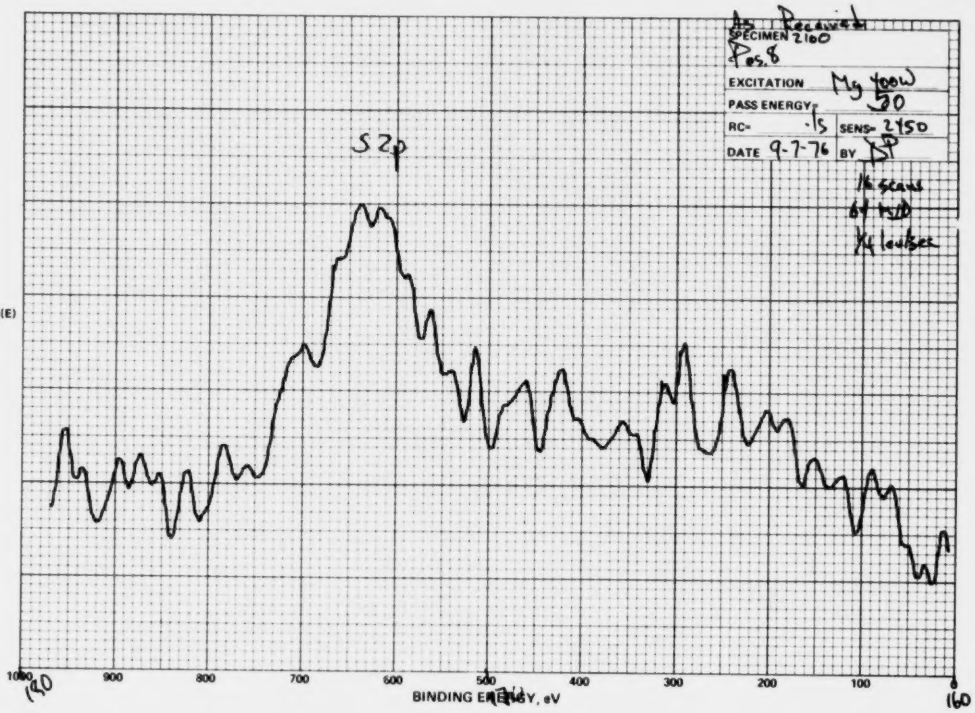


Figure F-51 - ESCA Graph - Run 25, Location 24N, Filter 2100

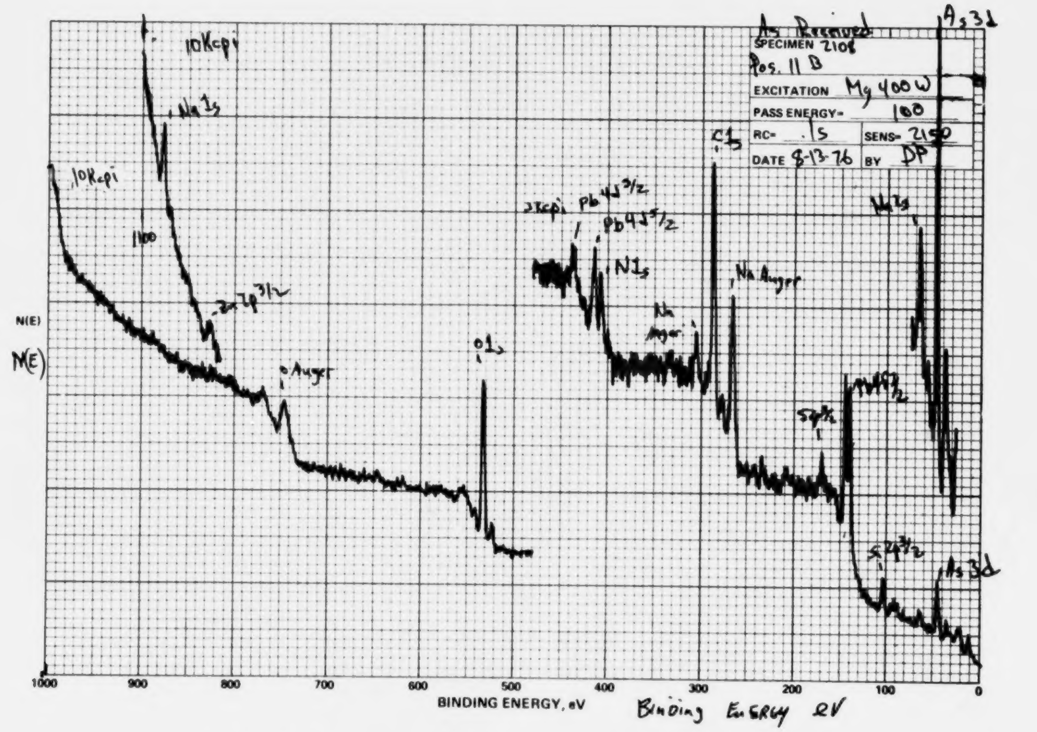


Figure F-52 - ESCA Graph - Run 29, Location 17, Sierra Backup, Filter 2108

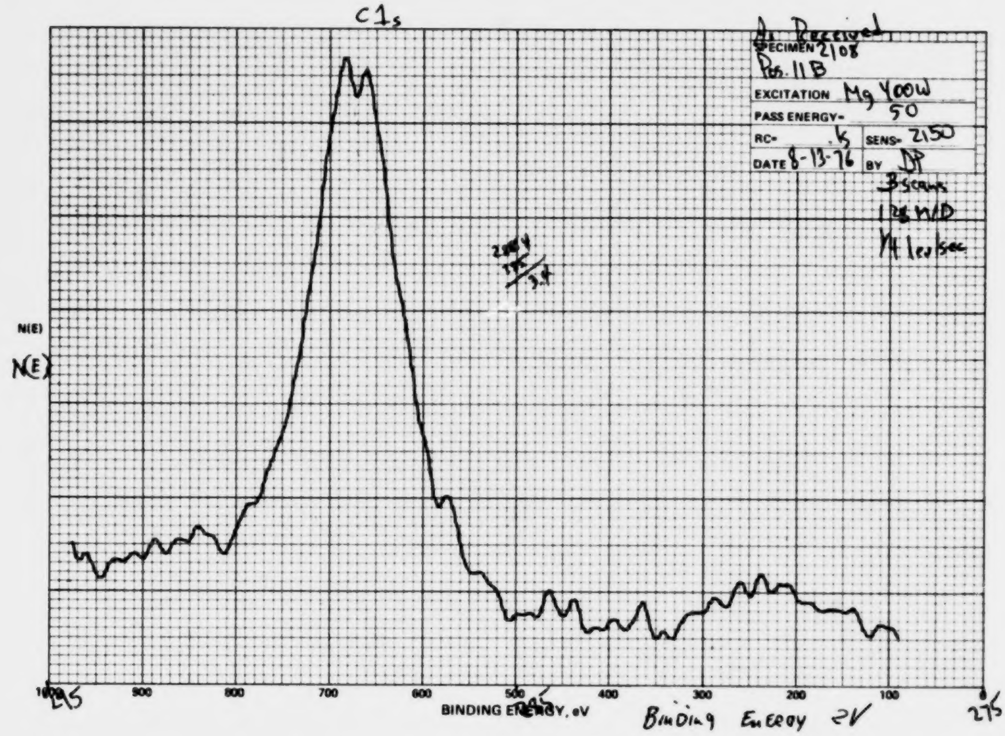


Figure F-53 - ESCA Graph - Run 29, Location 17, Sierra Backup, Filter 2108

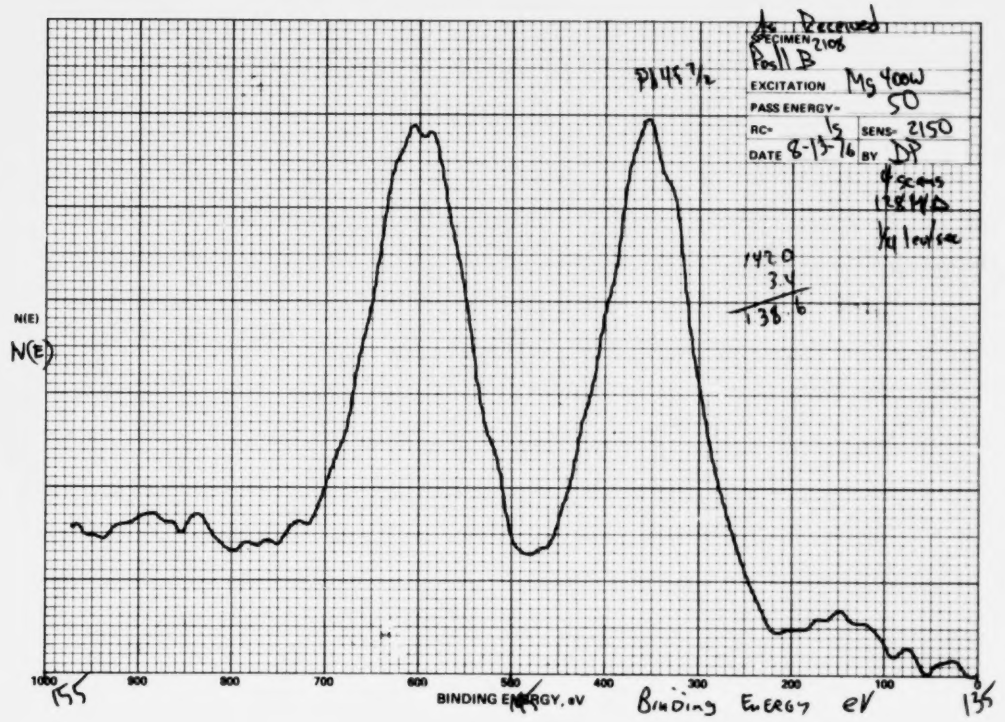


Figure F-54 - ESCA Graph - Run 29, Location 17, Sierra Backup, Filter 2108

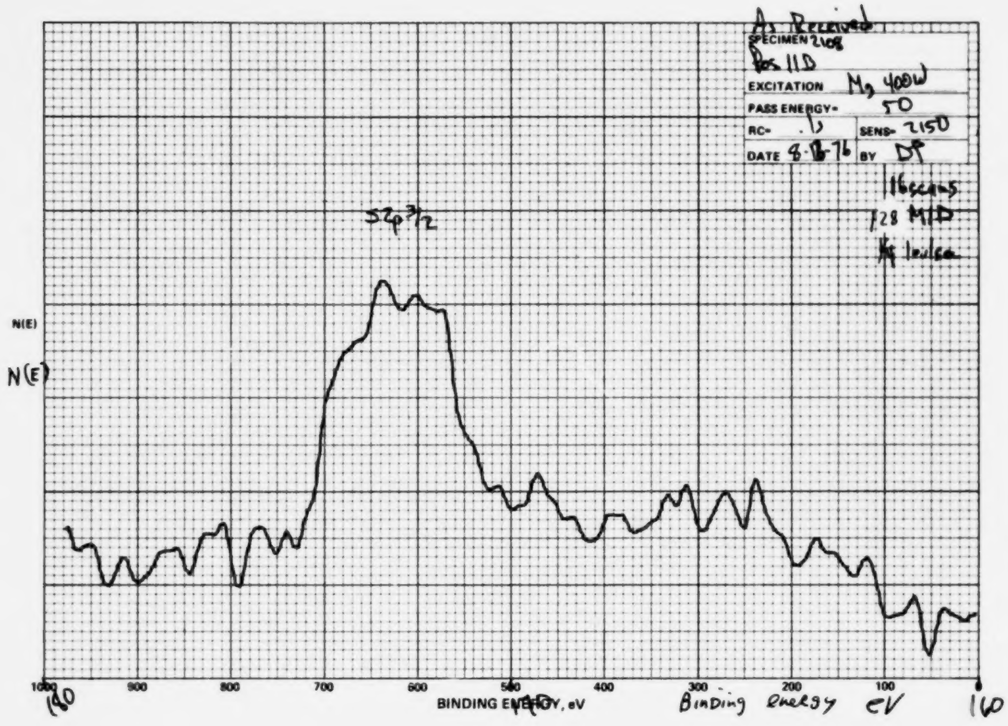


Figure F-55 - ESCA Graph - Run 29, Location 17, Sierra Backup, Filter 2108

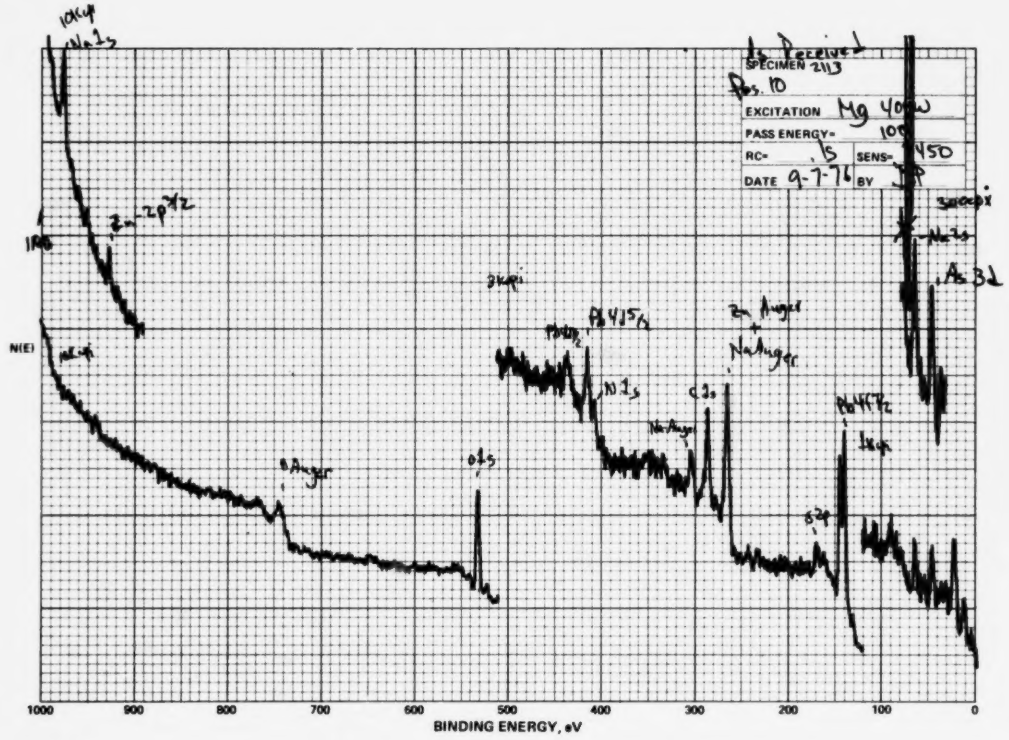


Figure F-56 - ESCA Graph - Run 30, Location 18, Filter 2113

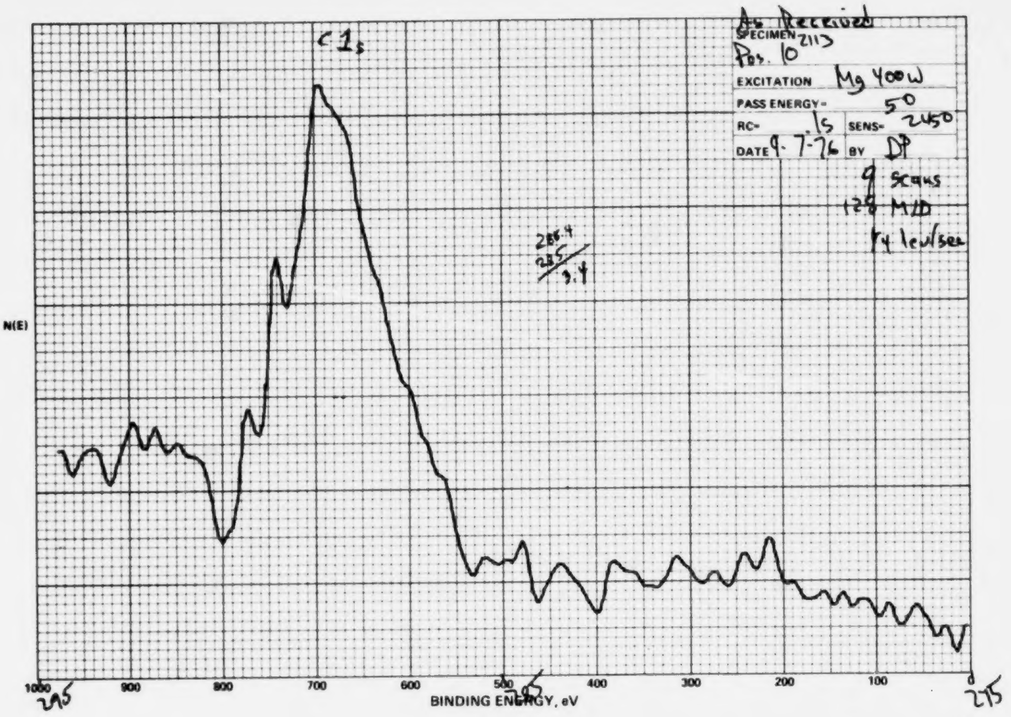


Figure F-57 - ESCA Graph - Run 30, Location 18, Filter 2113

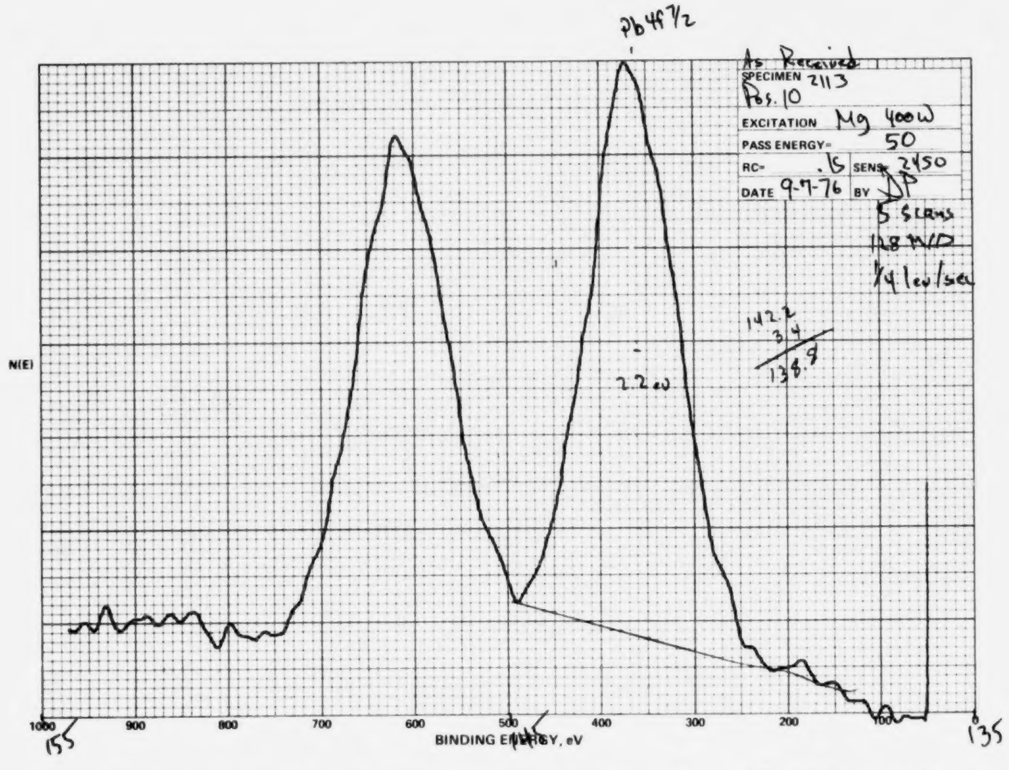


Figure F-58 - ESCA Graph - Run 30, Location 18, Filter 2113

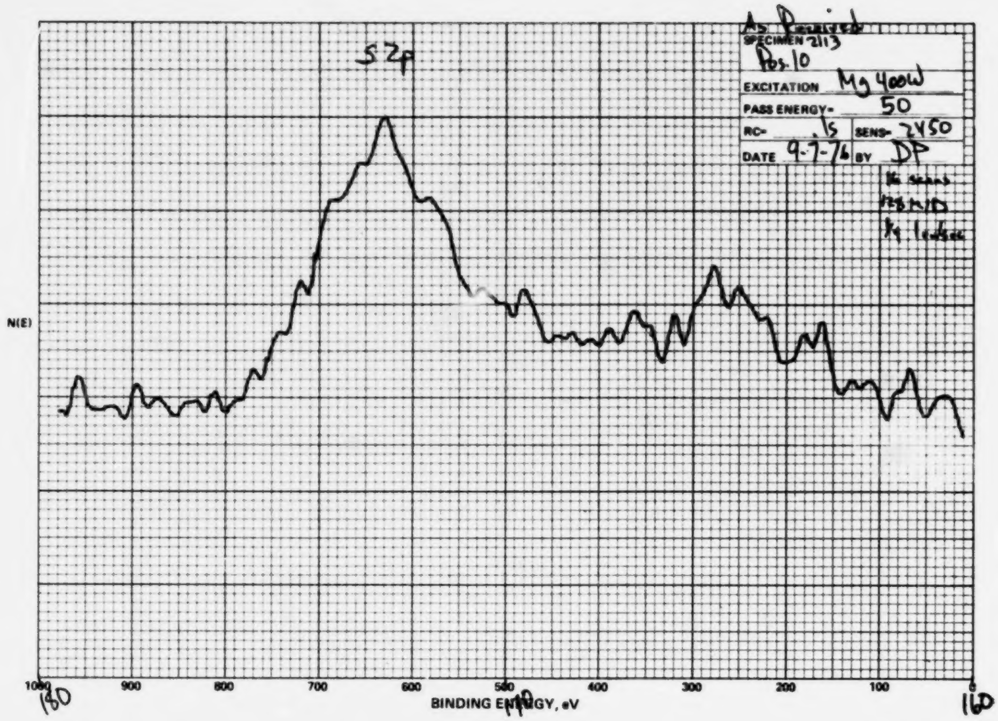


Figure F-59 - ESCA Graph - Run 30, Location 18, Filter 2113

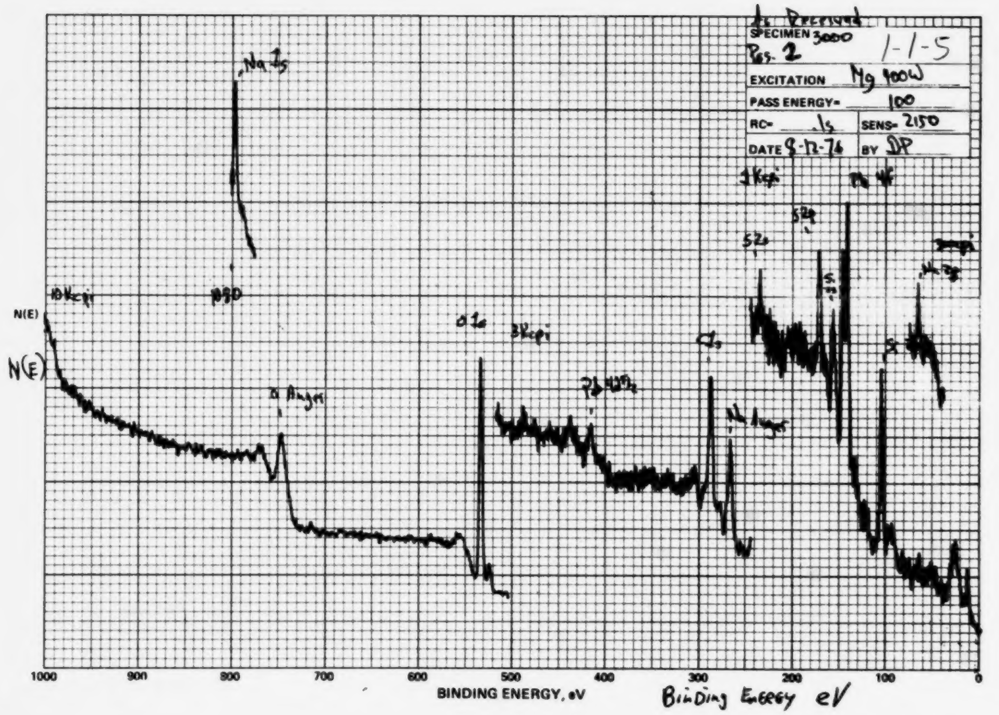


Figure F-60 - ESCA Graph - Run 1, Location 1, Stage 5, Filter 3000

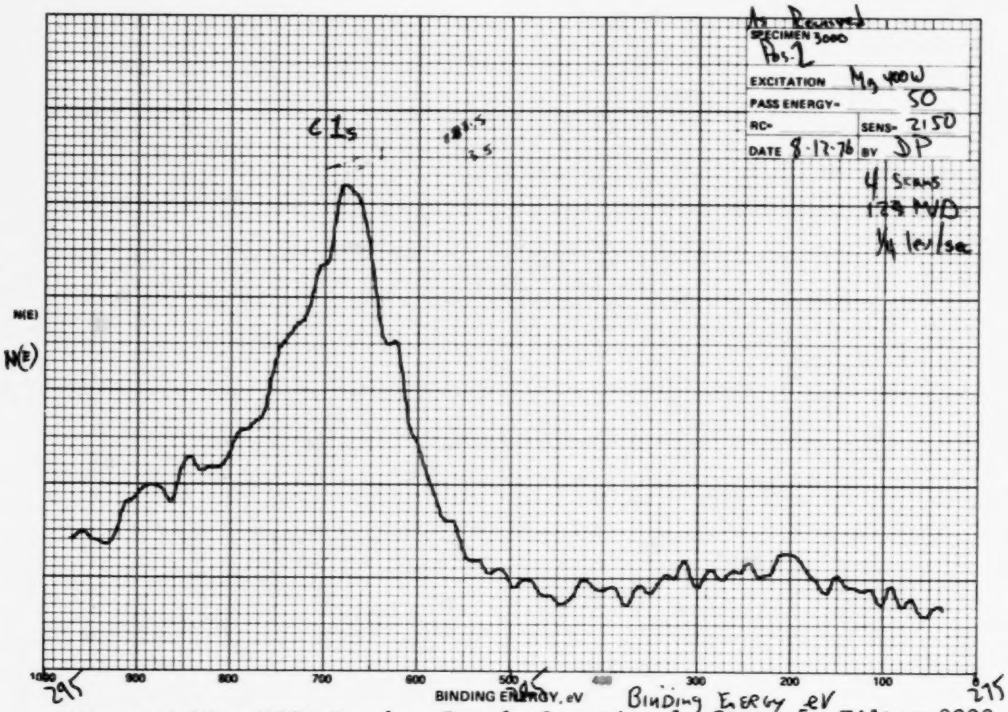


Figure F-61 - ESCA Graph - Run 1, Location 1, Stage 5, Filter 3000

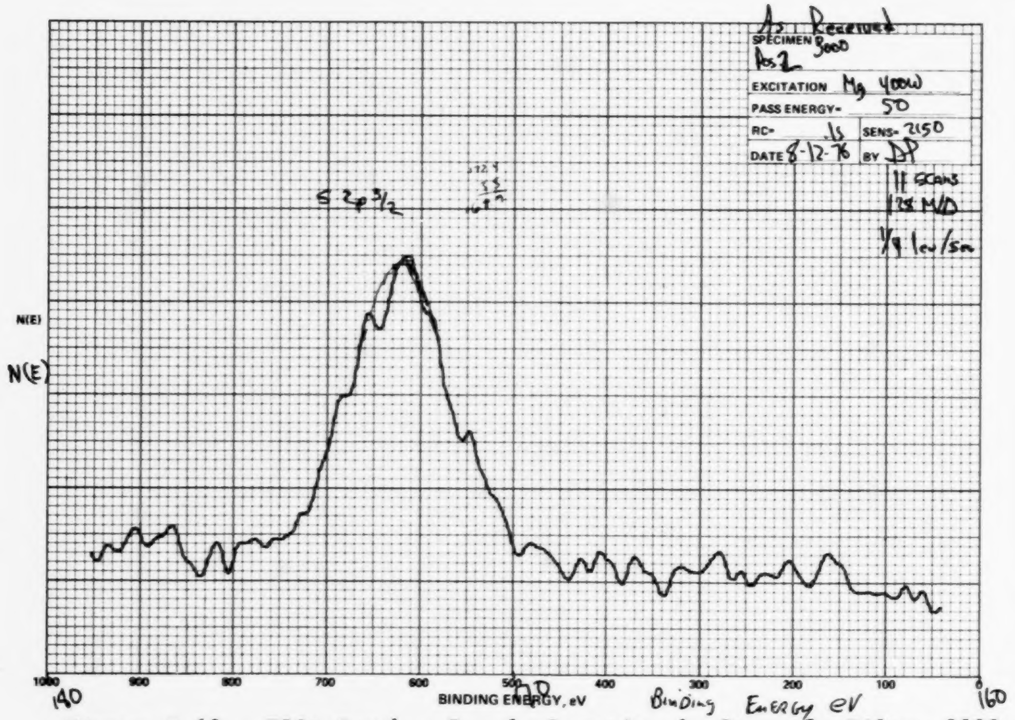


Figure F-62 - ESCA Graph - Run 1, Location 1, Stage 5, Filter 3000

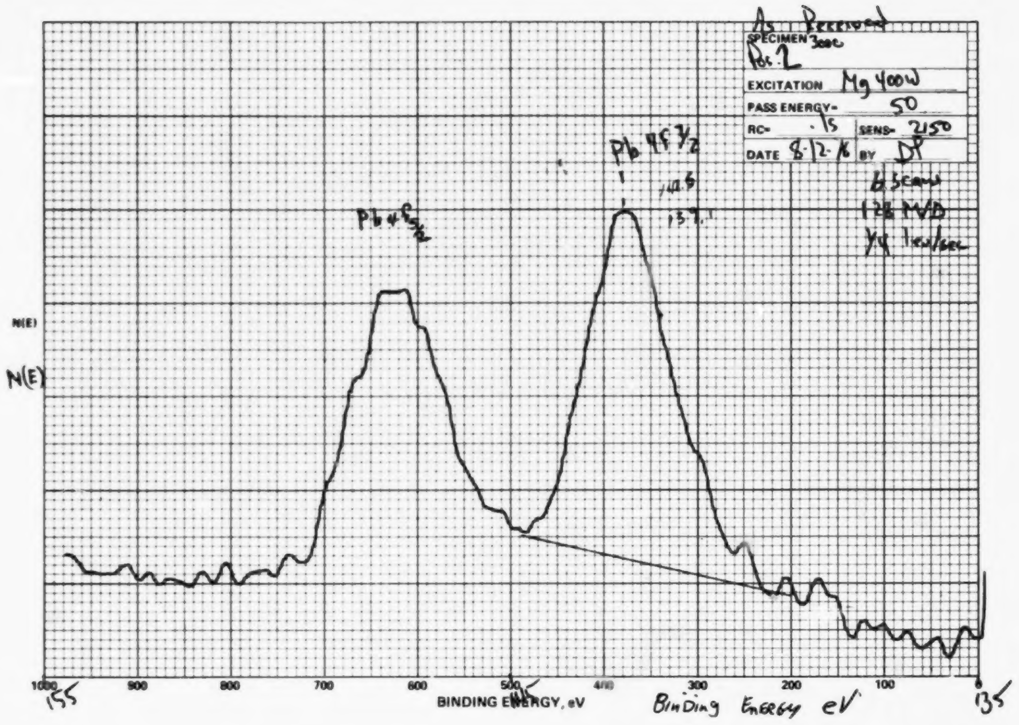


Figure F-63 - ESCA Graph - Run 1, Location 1, Stage 5, Filter 3000

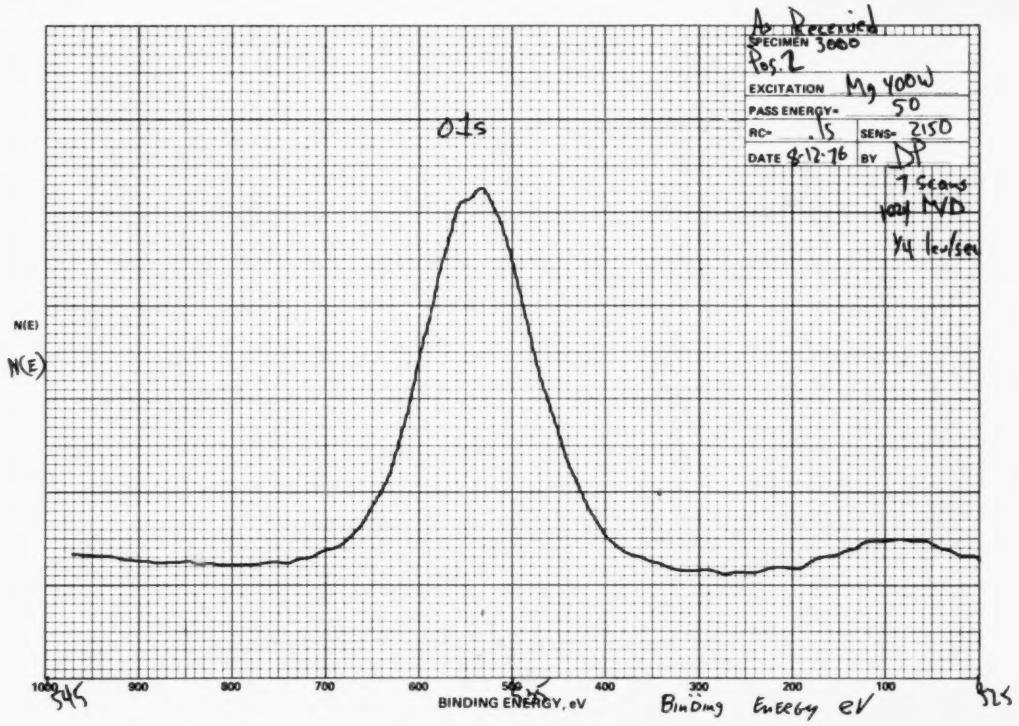


Figure F-64 - ESCA Graph - Run 1, Location 1, Stage 5, Filter 3000

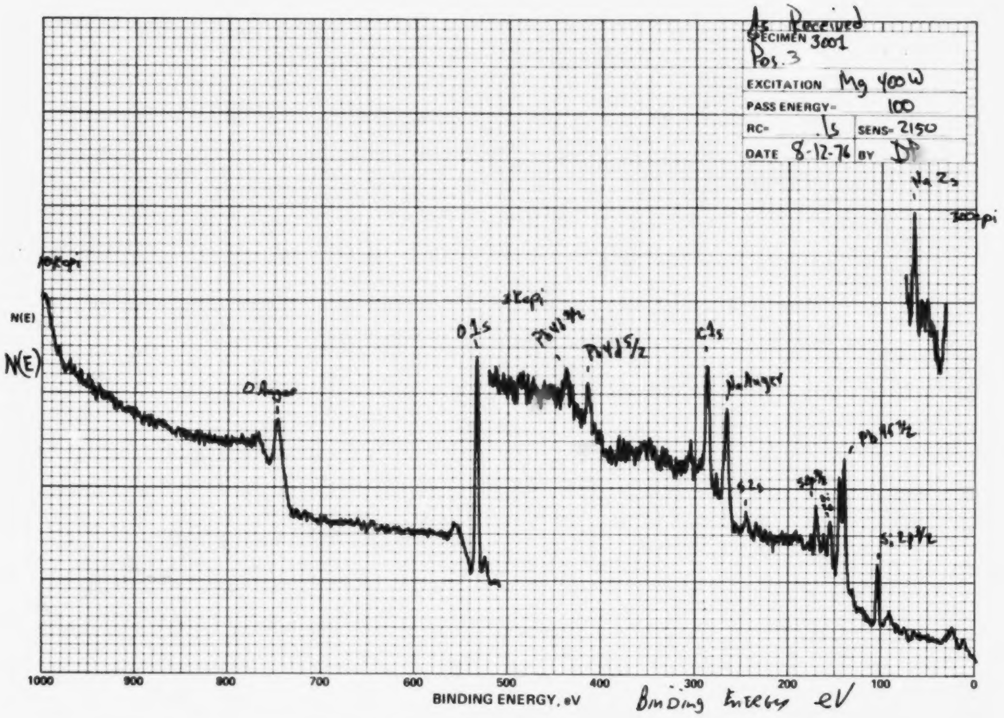


Figure F-65 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001

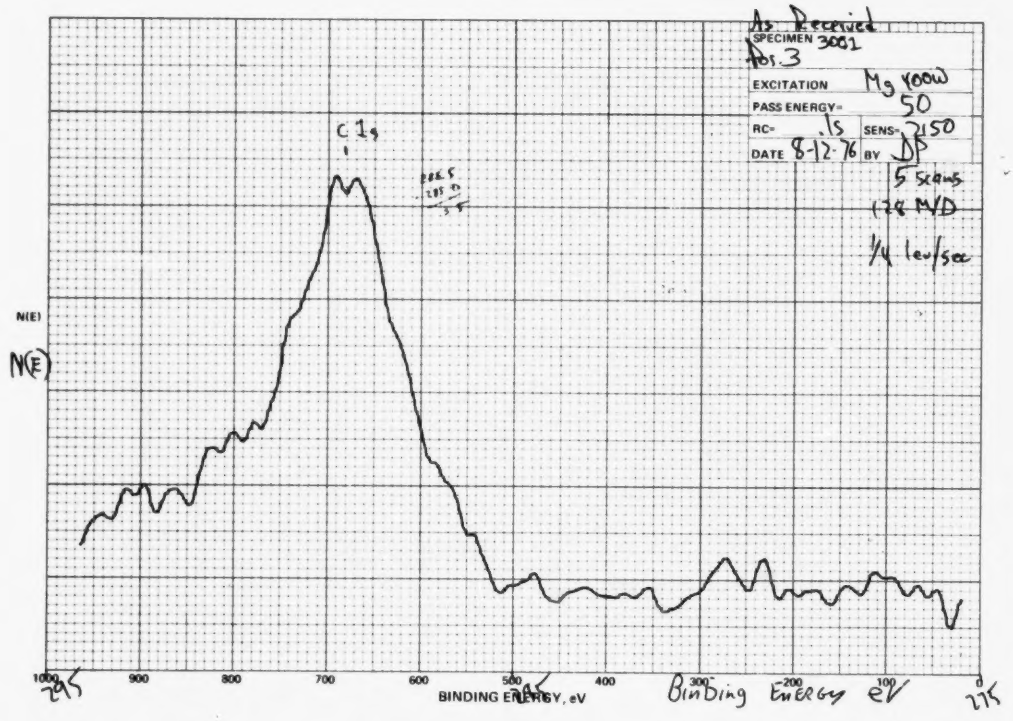
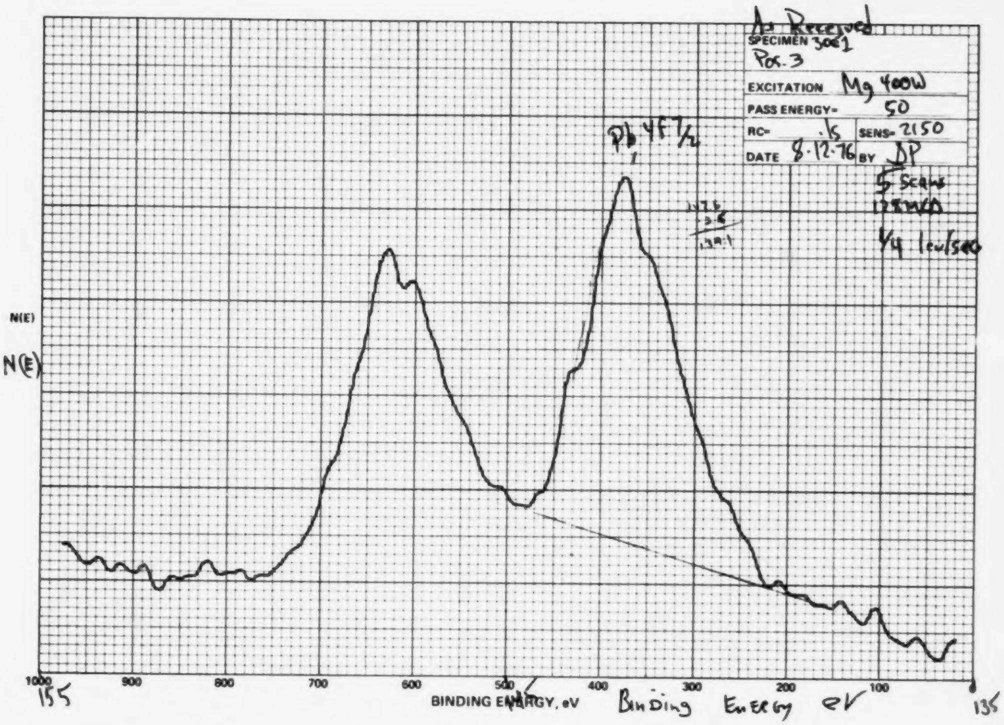


Figure F-66 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001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BY DP
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Figure F-67 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001

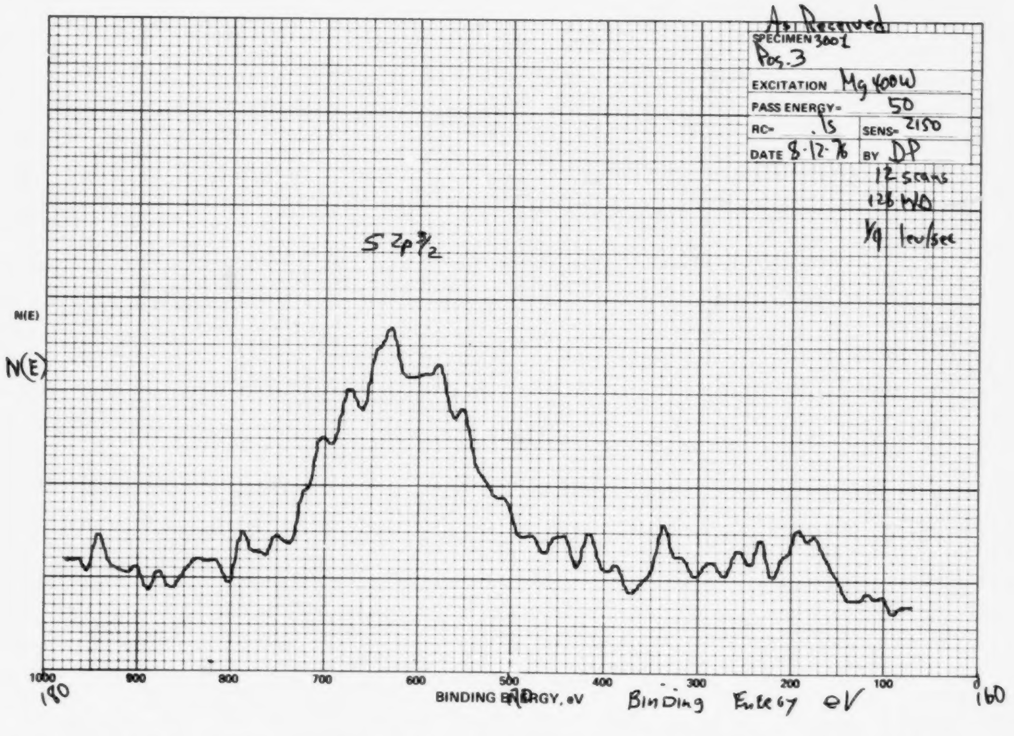
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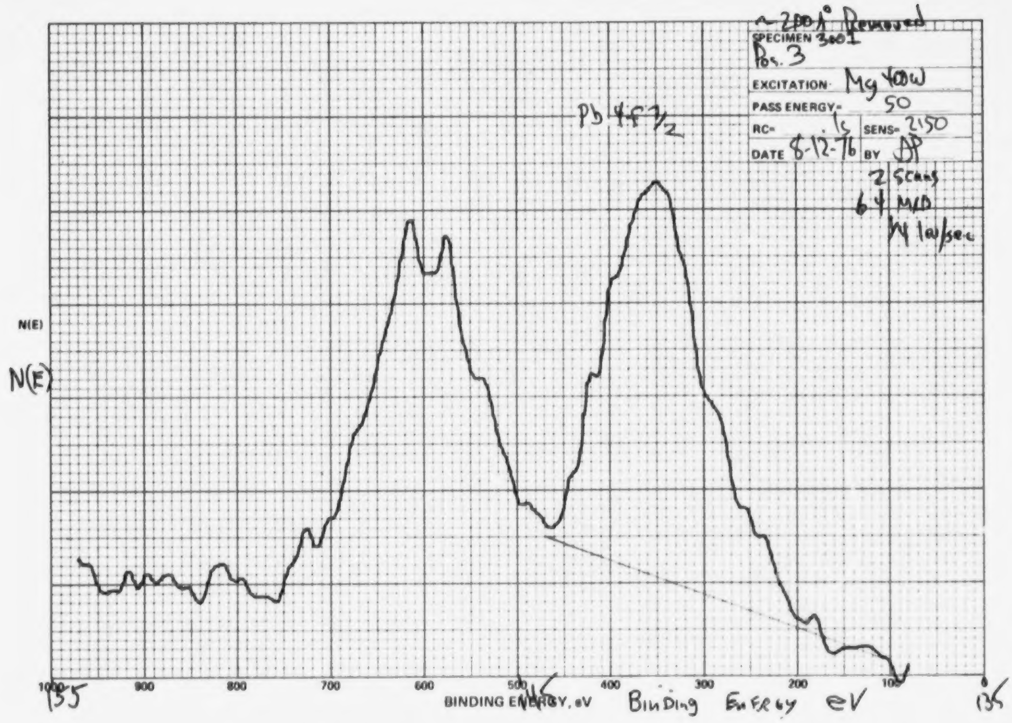
Figure F-68 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001



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Pos. 3
EXCITATION Mg 400W
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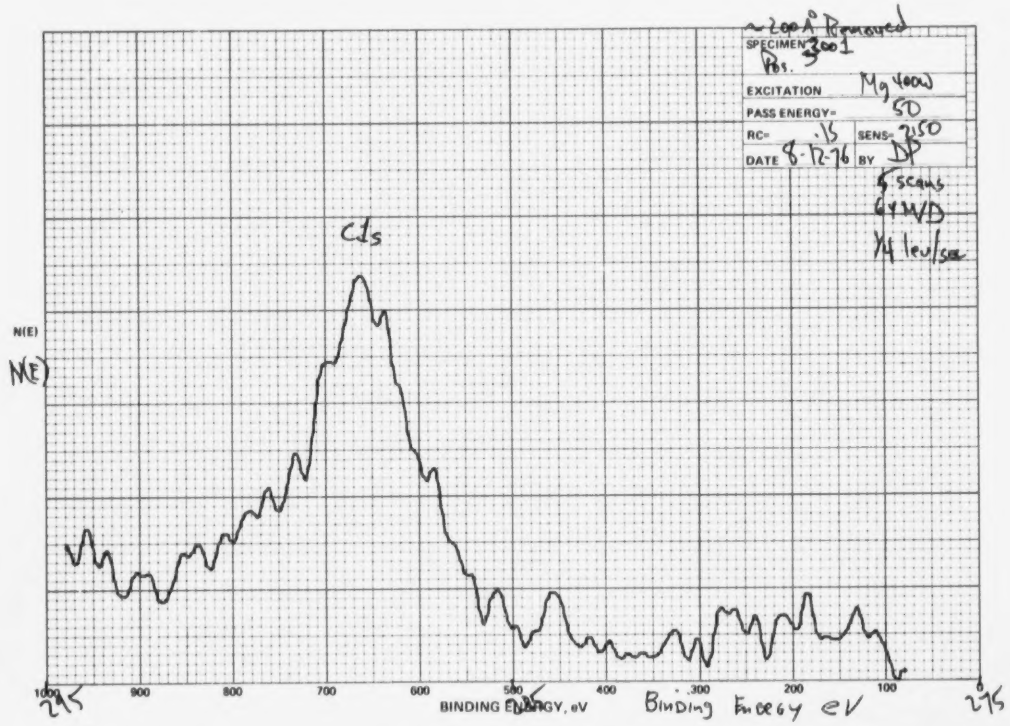
DATE 8-12-76
BY DP
2 scans
64 M/D
1/4 1ev/sec

Figure F-69 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001



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BY DP
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64 M/D
1/4 1ev/sec

Figure F-70 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001

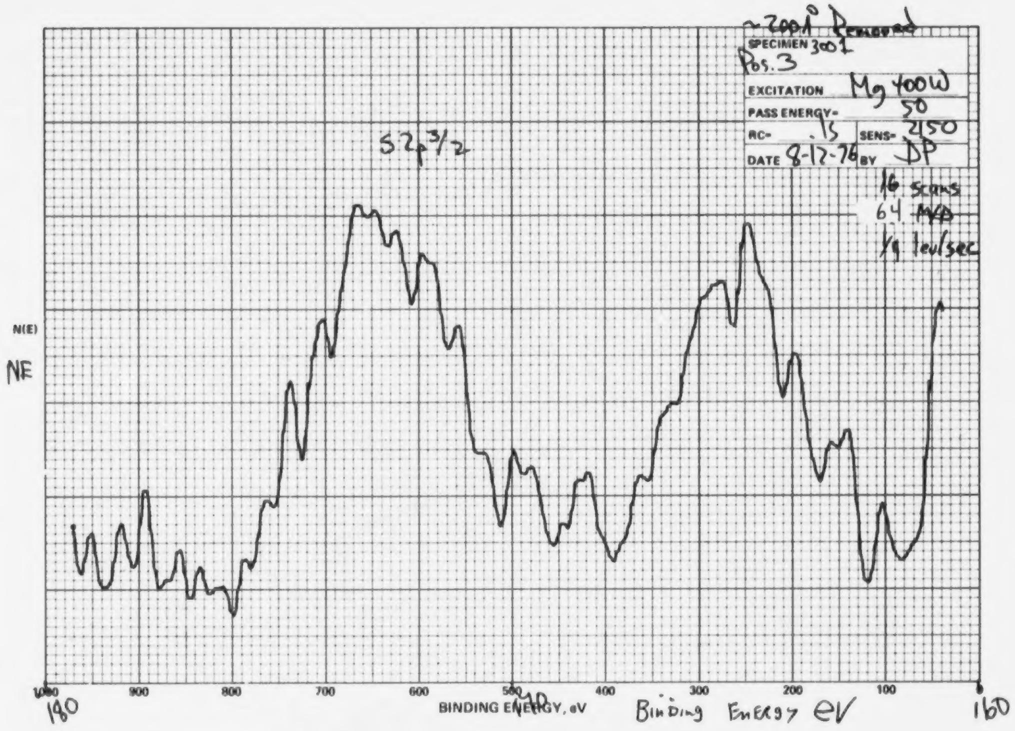


Figure F-71 - ESCA Graph - Run 1, Location 1, Stage 4, Filter 3001

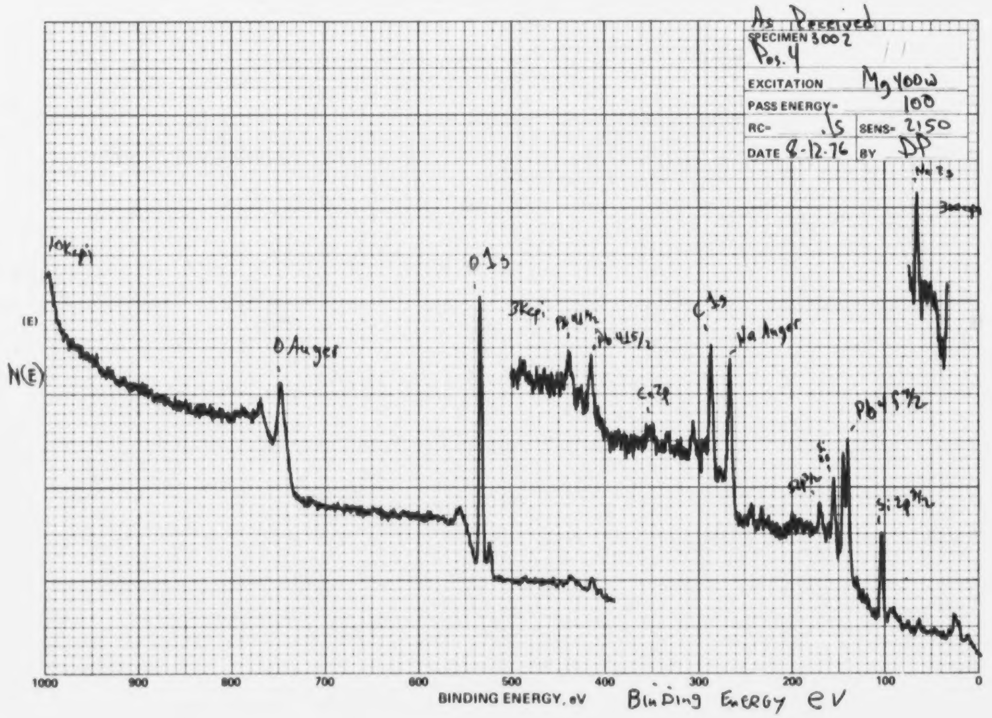


Figure F-72 - ESCA Graph - Run 1, Location 1, Stage 3, Filter 3002

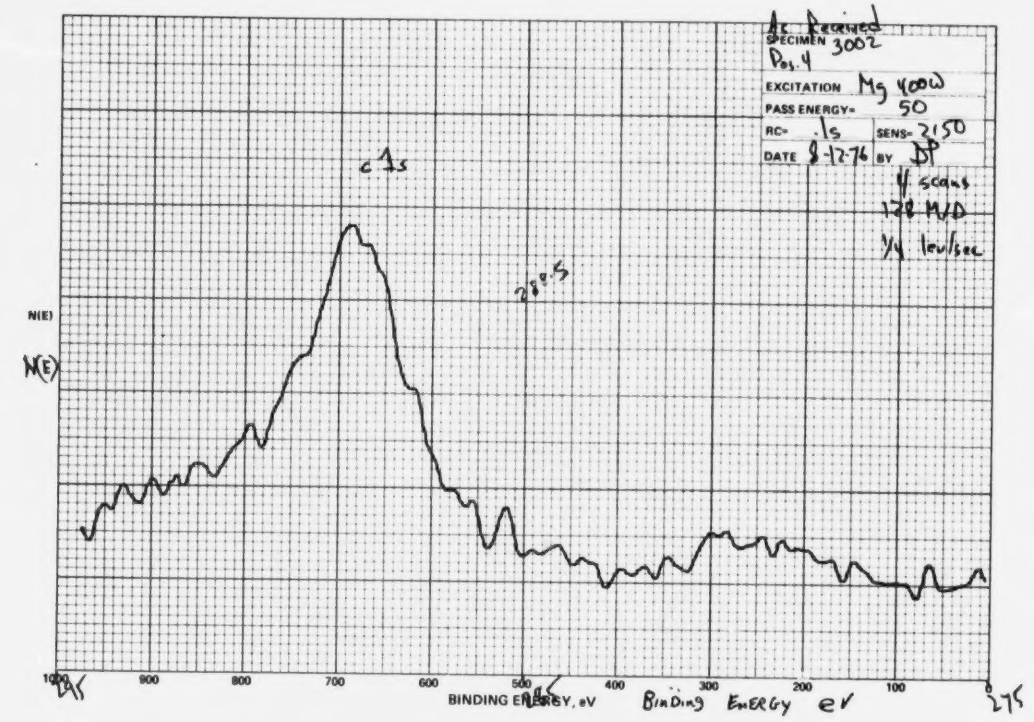


Figure F-73 - ESCA Graph - Run 1, Location 1, Stage 3, Filter 3002

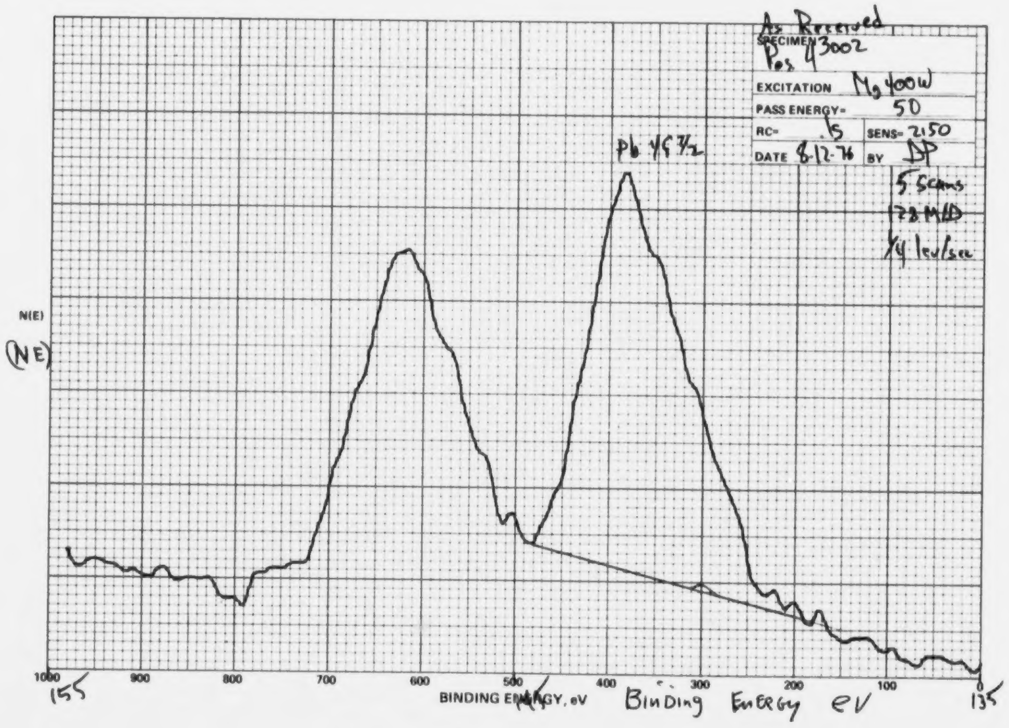


Figure F-74 - ESCA Graph - Run 1, Location 1, Stage 3, Filter 3002

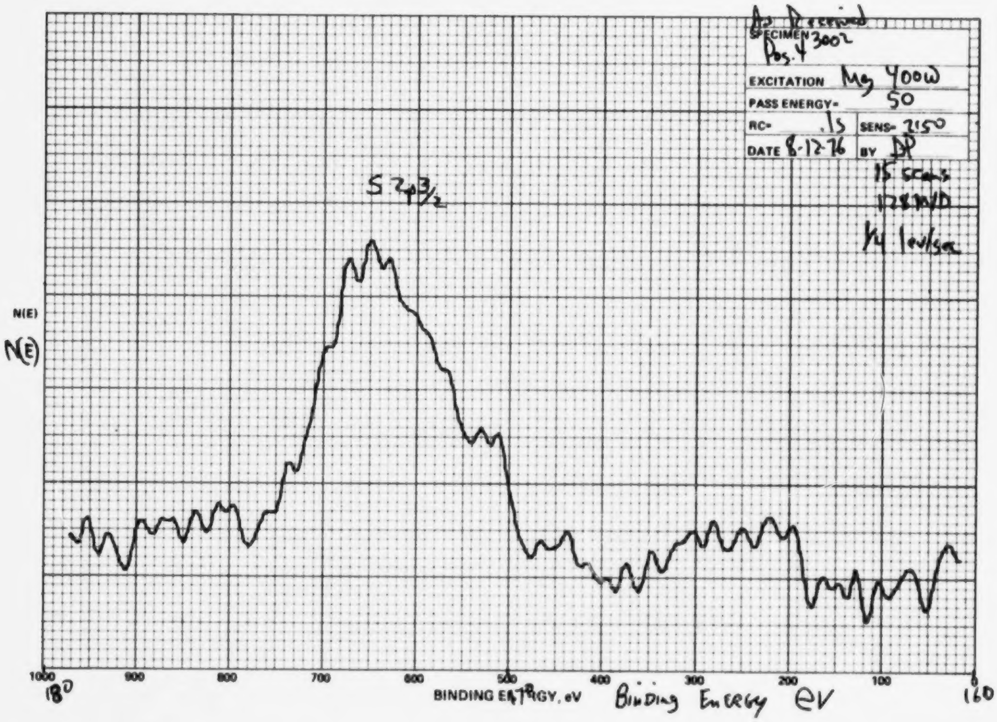


Figure F-75 - ESCA Graph - Run 1, Location 1, Stage 3, Filter 3002

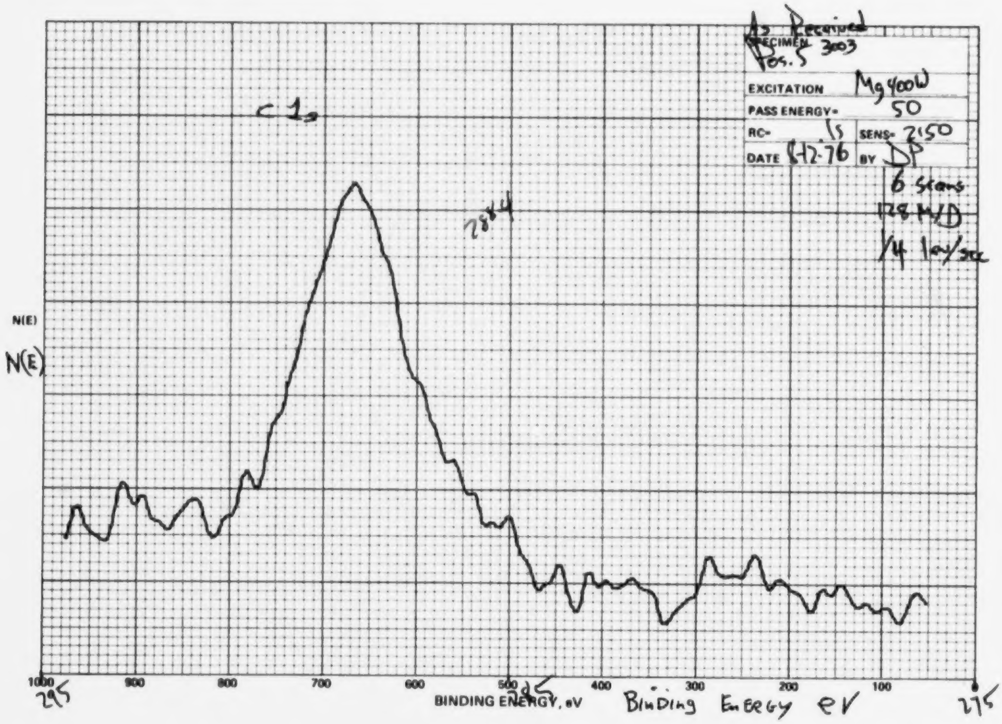


Figure F-76 - ESCA Graph - Run 1, Location 1, Stage 2, Filter 3003

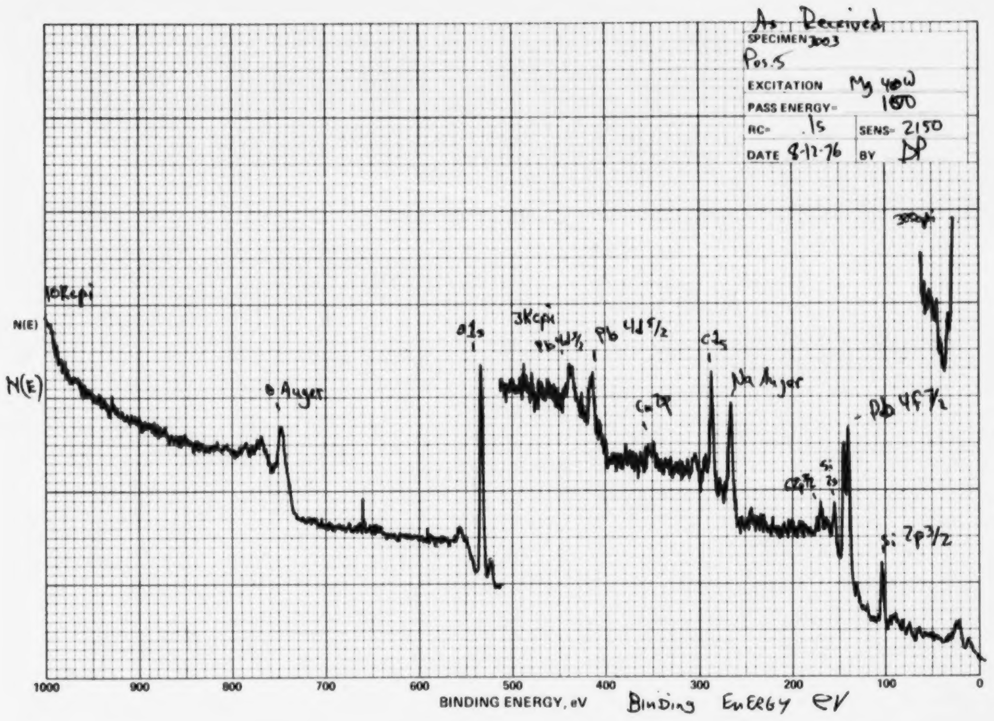


Figure F-77 - ESCA Graph - Run 1, Location 1, Stage 2, Filter 3003

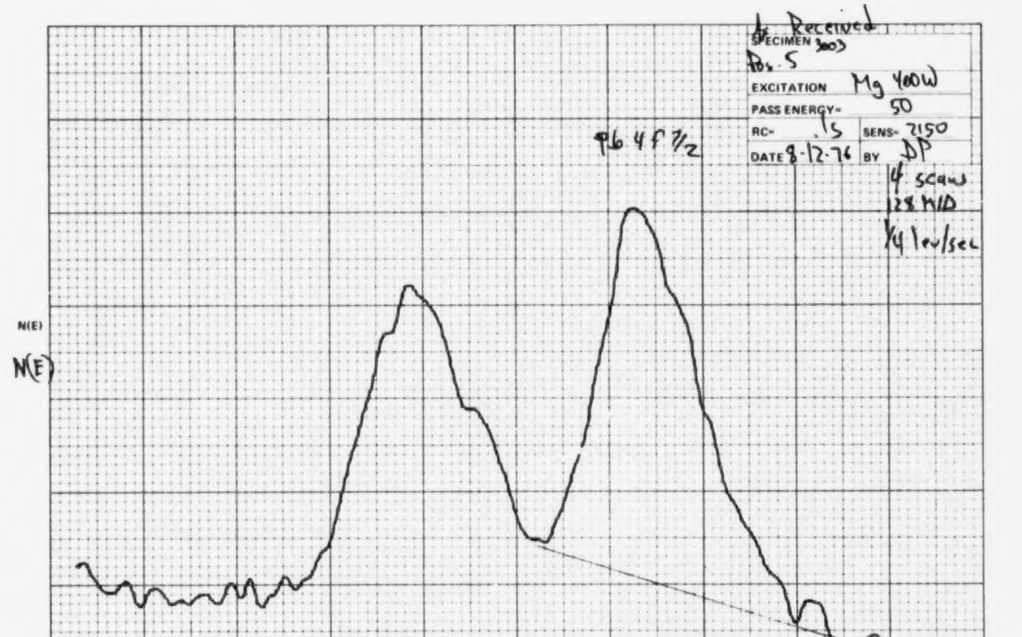


Figure F-78 - ESCA Graph - Run 1, Location 1, Stage 2, Filter 3003

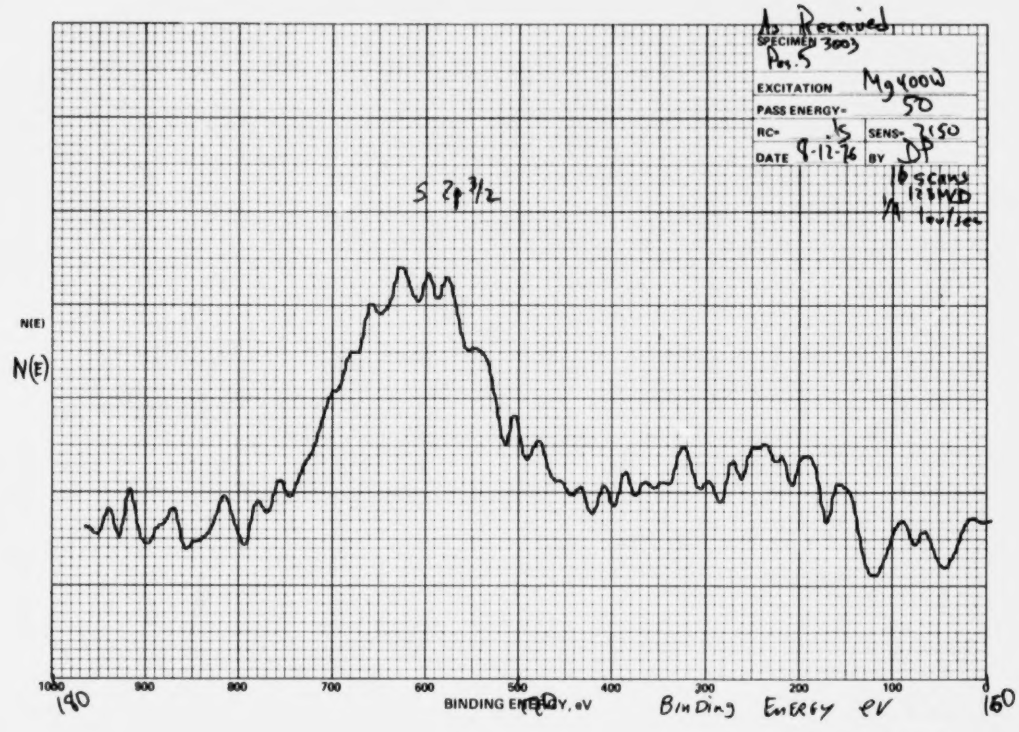


Figure F-79 - ESCA Graph - Run 1, Location 1, Stage 2, Filter 3003

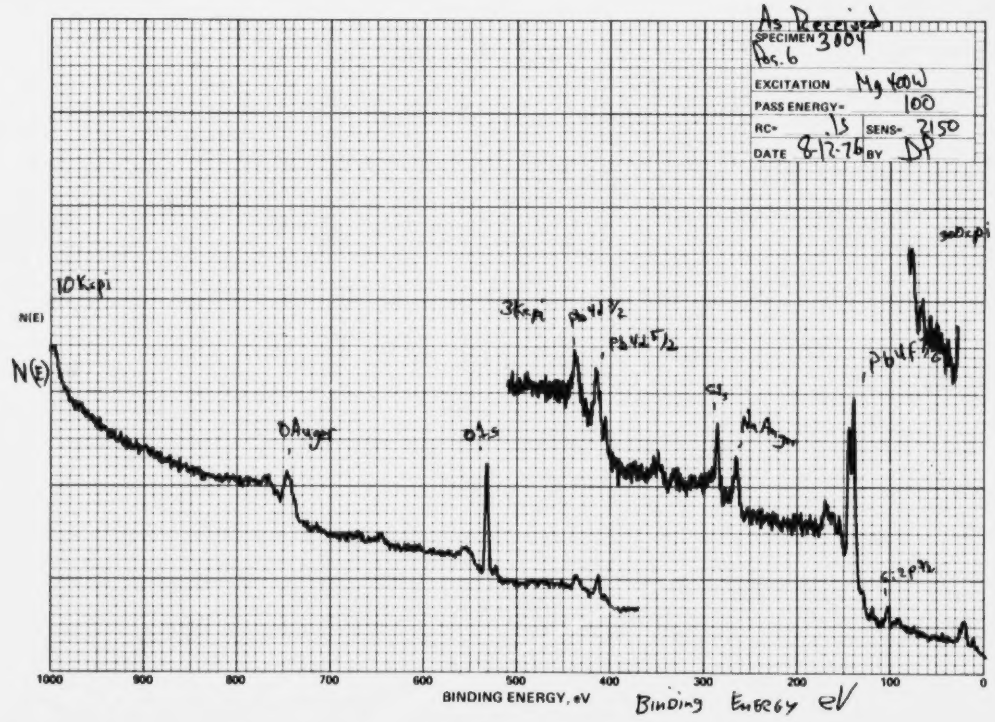


Figure F-80 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004

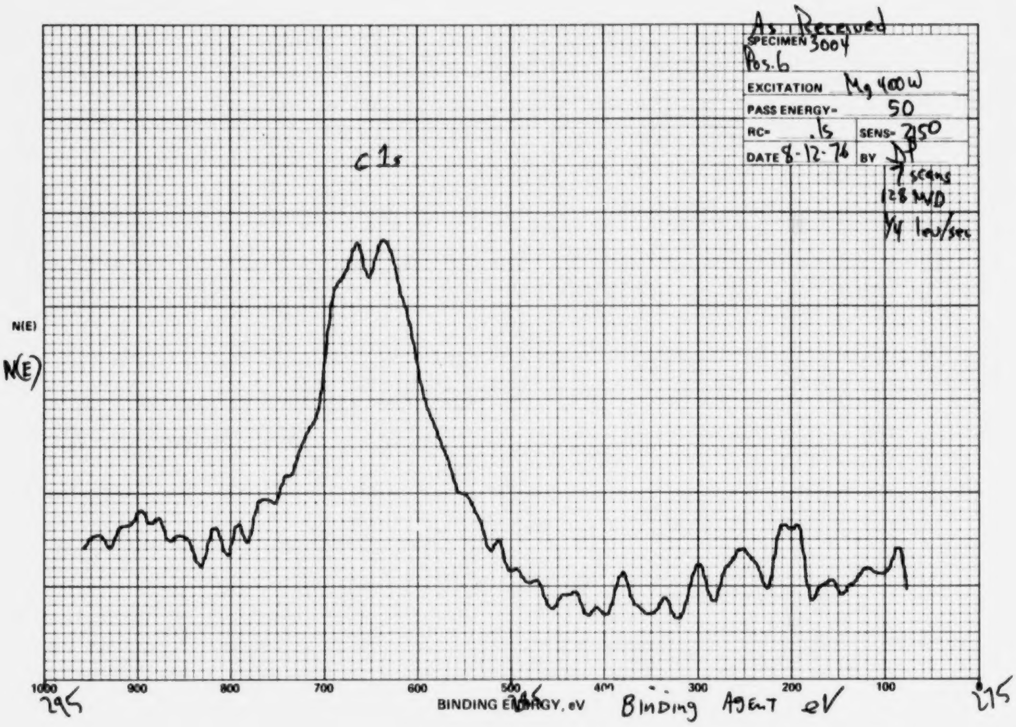


Figure F-81 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004

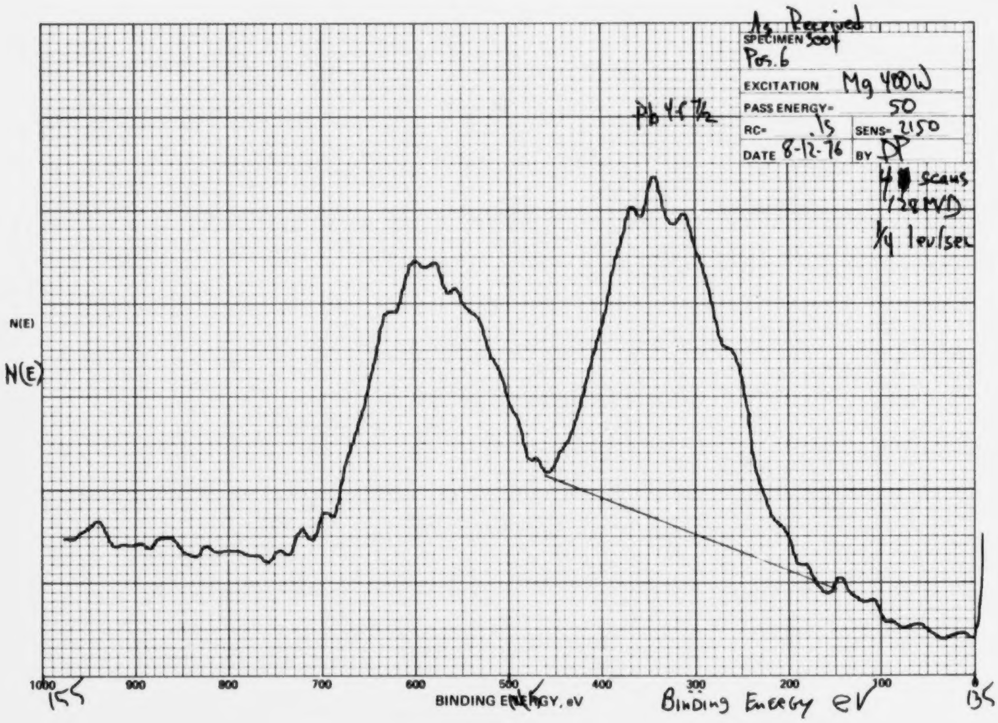


Figure F-82 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004

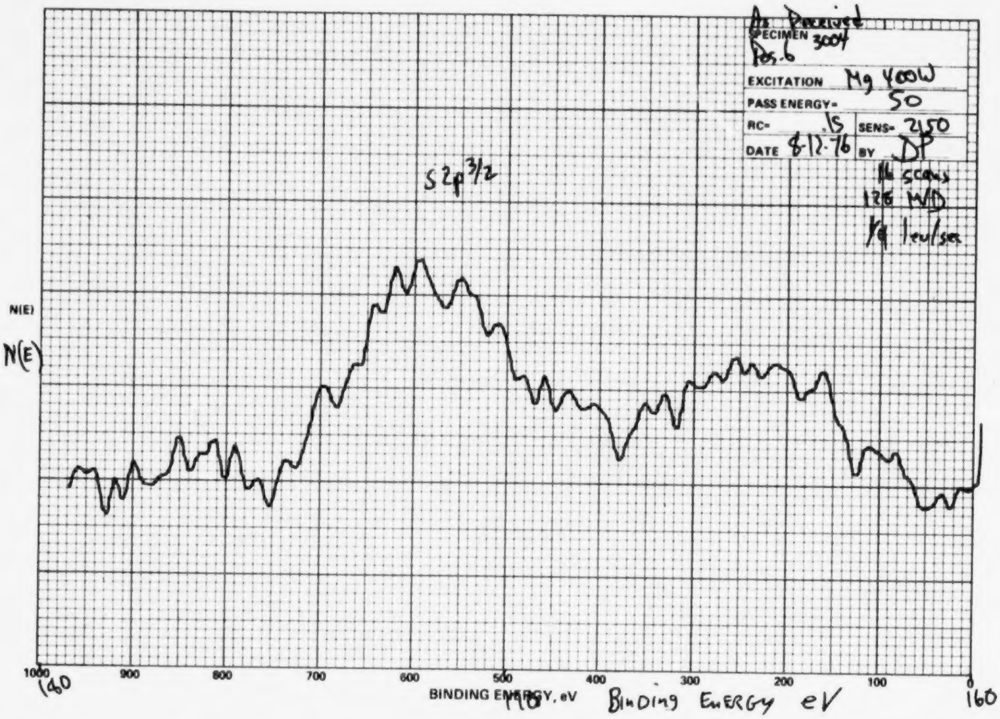


Figure F-83 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004

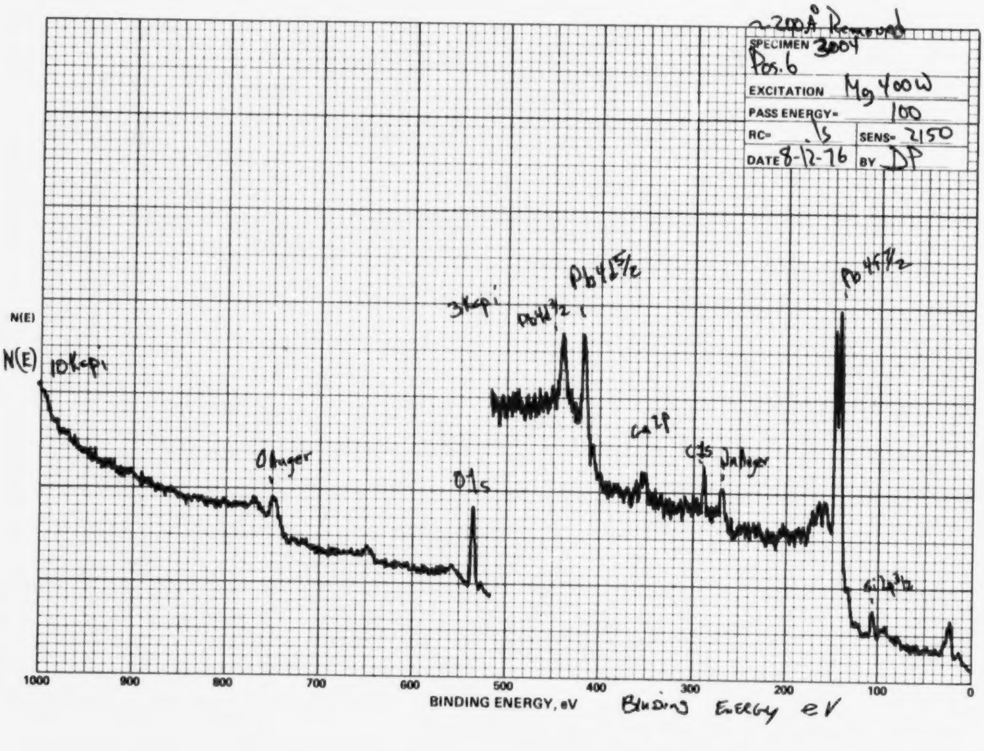


Figure F-84 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004

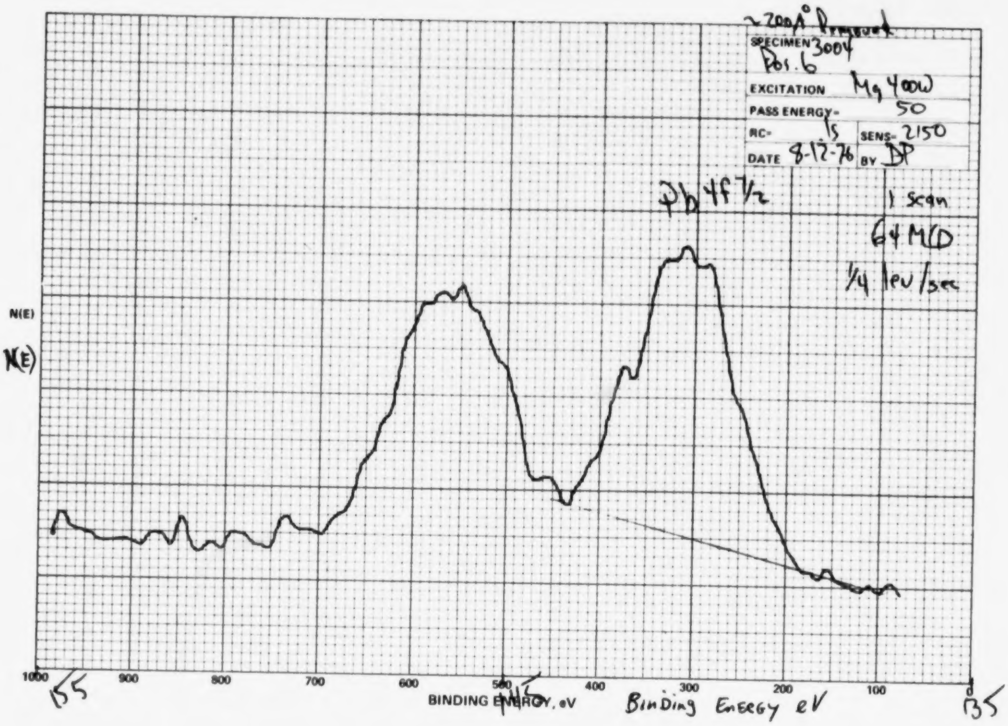


Figure F-85 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004

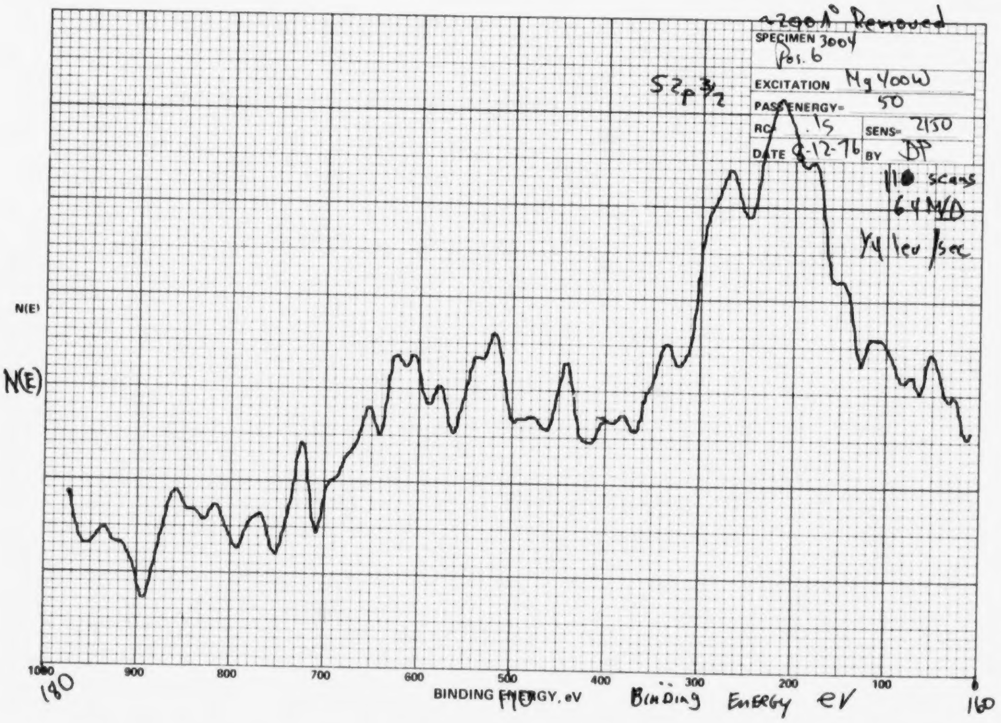
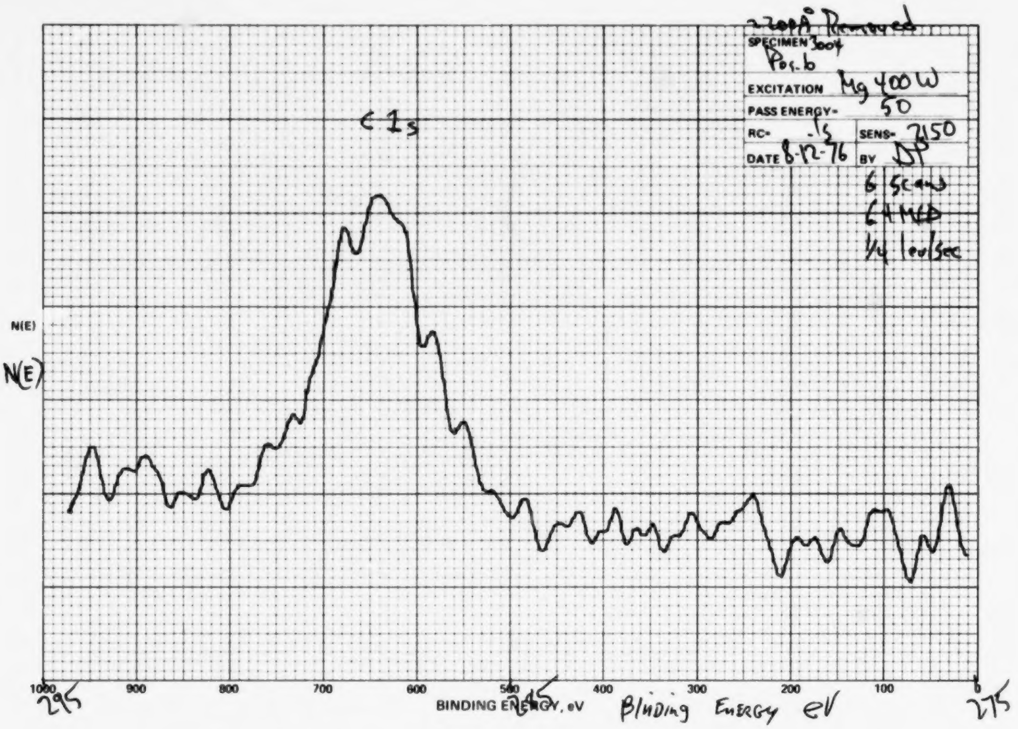


Figure F-86 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004



2200Å Removed

SPECIMEN 3004 Pos. b

EXCITATION Mg 400 W

PASS ENERGY= 50

RC= .1s SENS= 2150

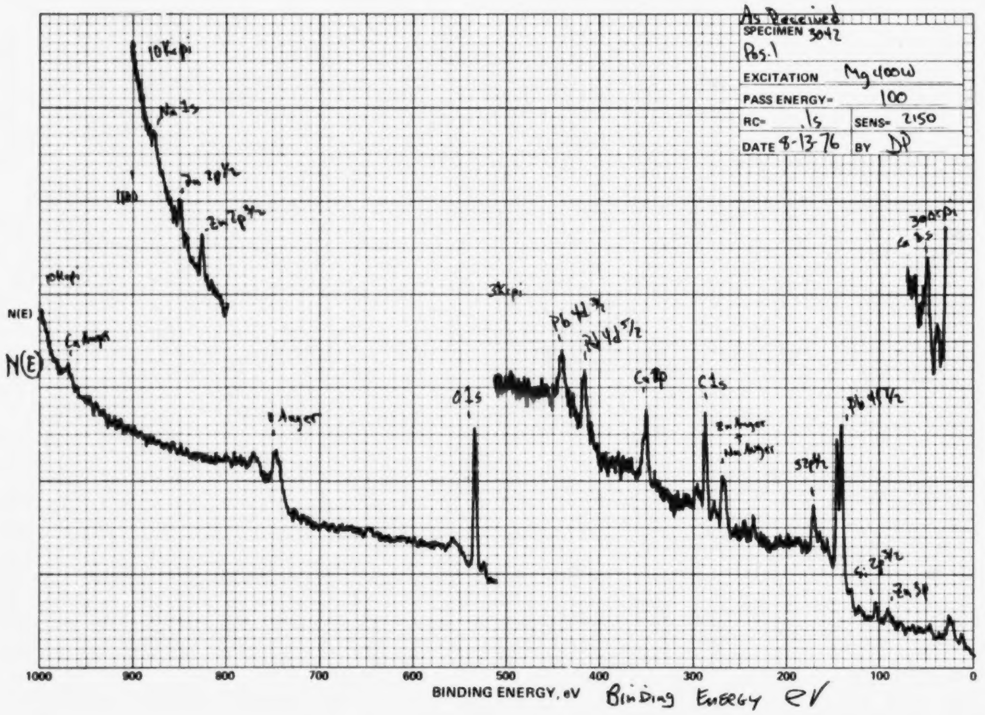
DATE 8-12-76 BY DP

6 Scans

64 MED

1/4 lev/sec

Figure F-87 - ESCA Graph - Run 1, Location 1, Stage 1, Filter 3004



As Received

SPECIMEN 3042 Pos. 1

EXCITATION Mg 400W

PASS ENERGY= 100

RC= .1s SENS= 2150

DATE 8-13-76 BY DP

Figure F-88 - ESCA Graph - Run 21, Location 11, Stage 1, Filter 3042

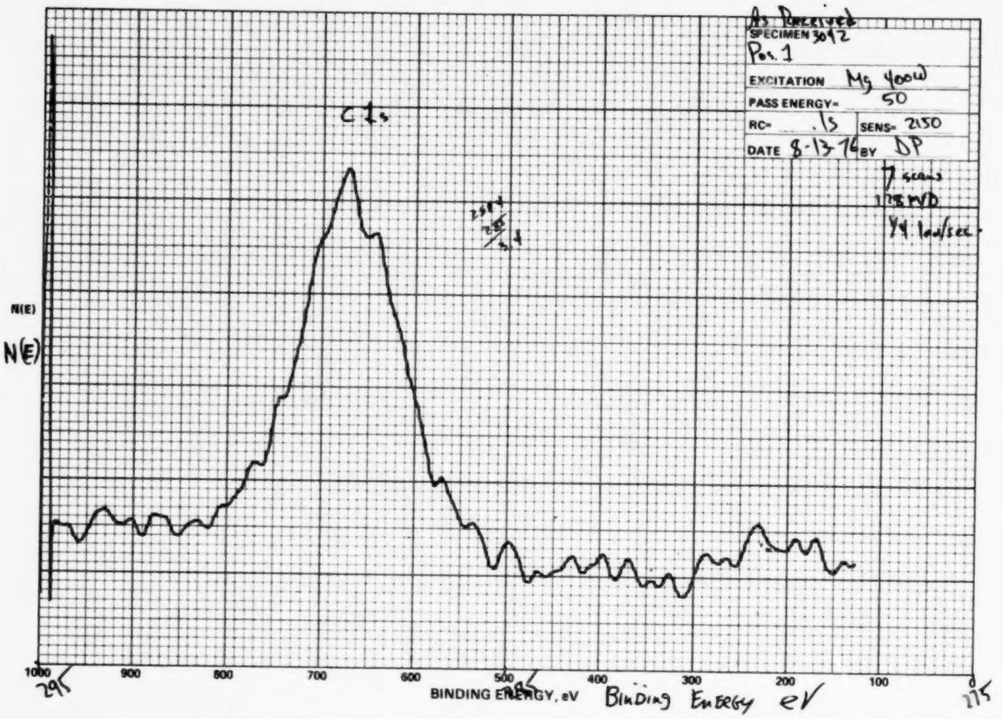


Figure F-89 - ESCA Graph - Run 21, Location 11, Stage 1, Filter 3042

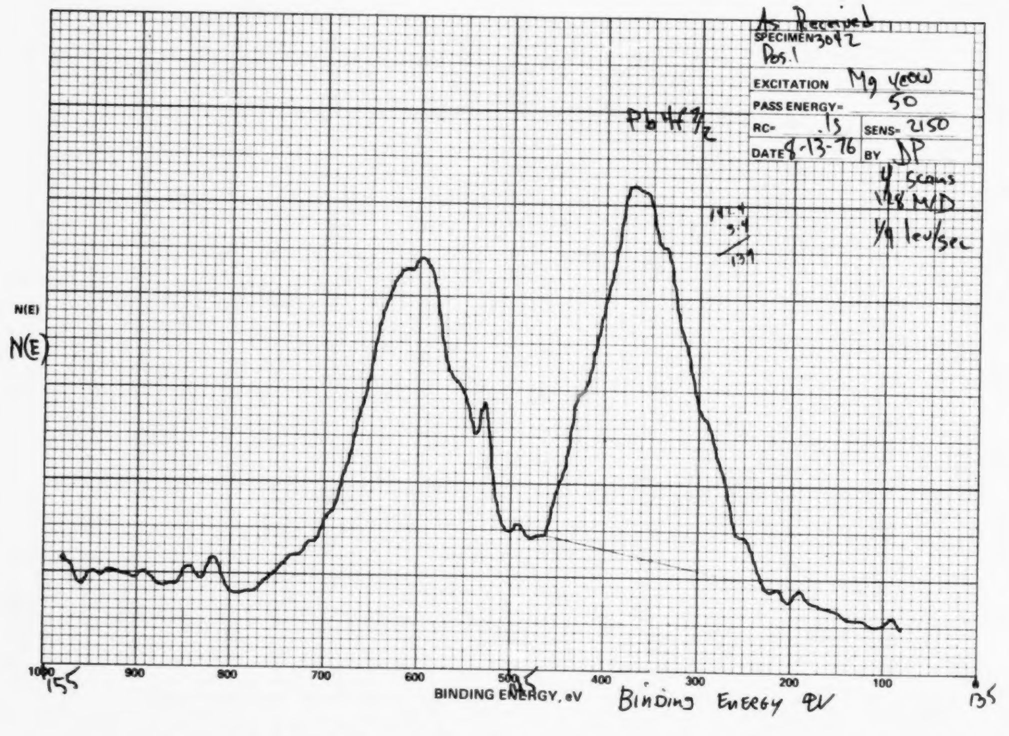


Figure F-90 - ESCA Graph - Run 21, Location 11, Stage 1, Filter 3042

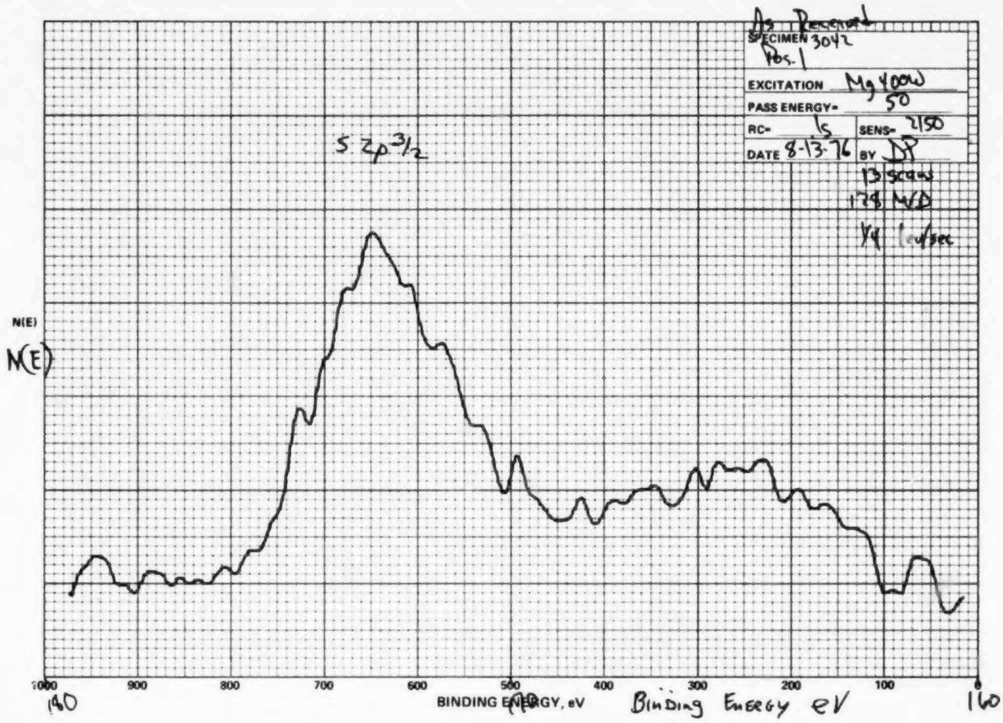


Figure F-91 - ESCA Graph - Run 21, Location 11, Stage 1, Filter 3042

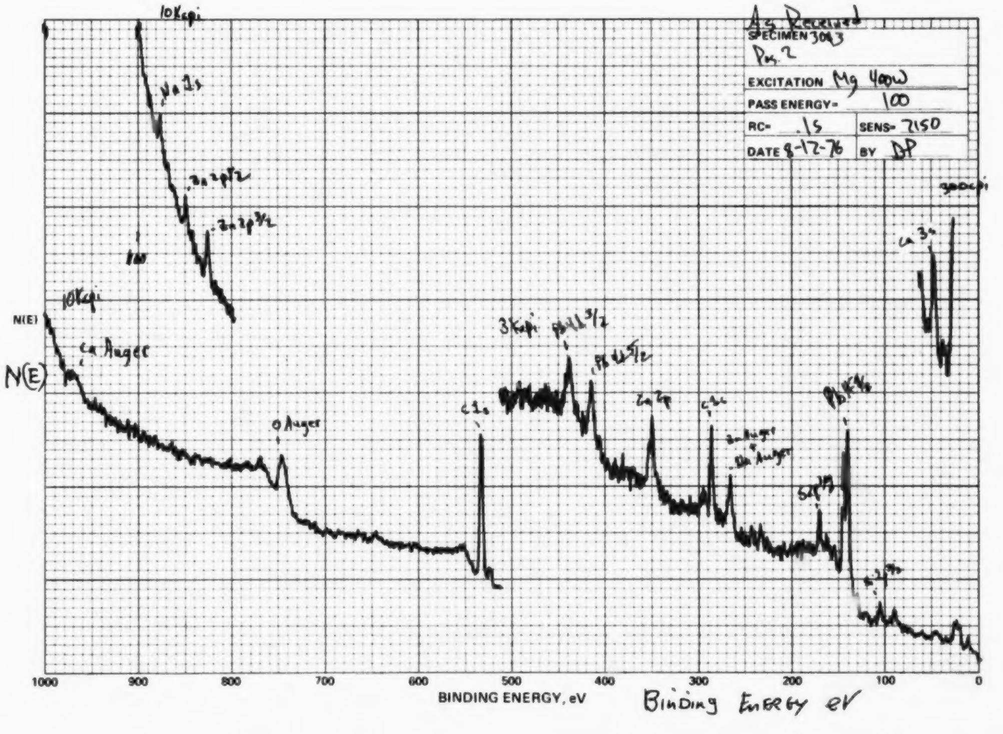
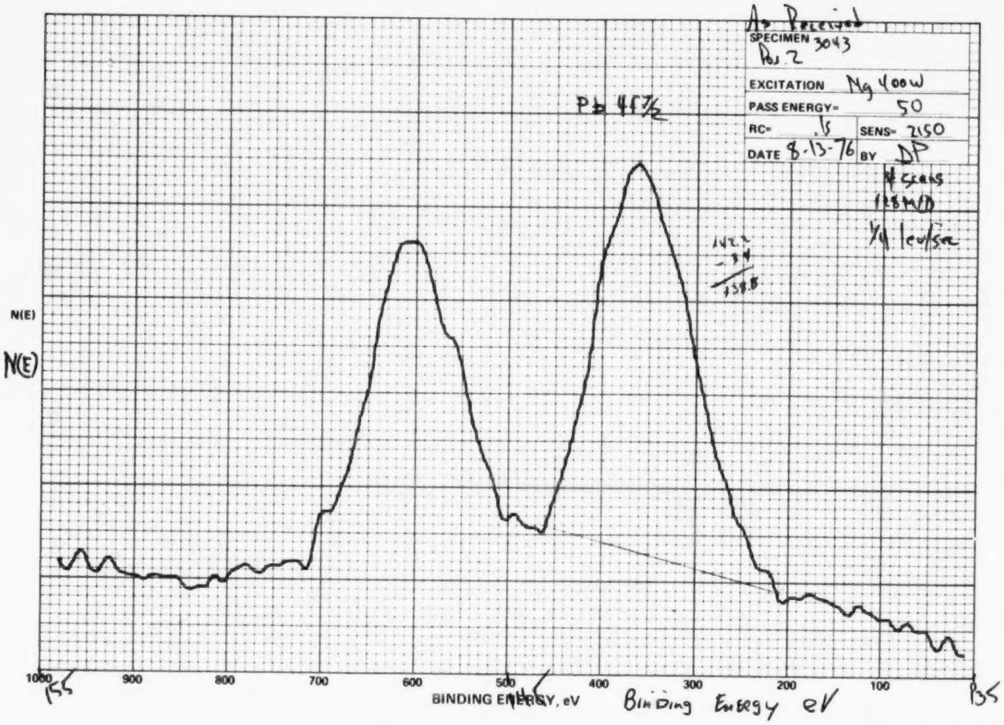


Figure F-92 - ESCA Graph - Run 21, Location 11, Stage 2, Filter 3043



As Received

SPECIMEN 3043 Pos. 2

EXCITATION Mg 400W

PASS ENERGY= 50

RC= .15 SENS= 2150

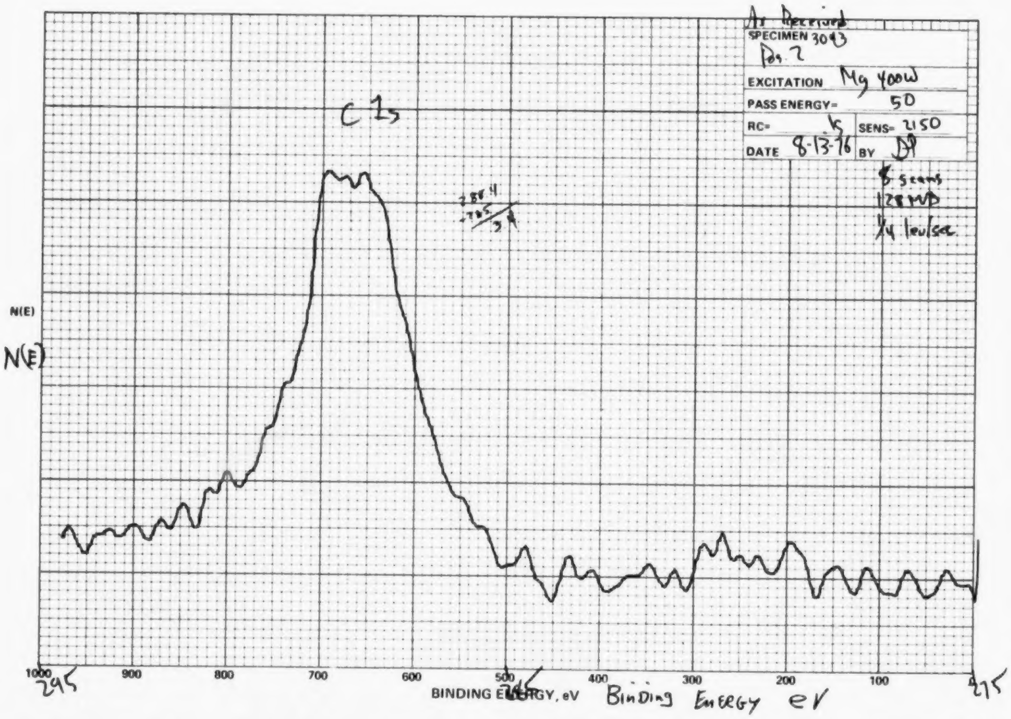
DATE 8-13-76 BY DP

4 scans

128 MID

1/4 lev/sec

Figure F-93 - ESCA Graph - Run 21, Location 11, Stage 2, Filter 3043



As Received

SPECIMEN 3043 Pos. 2

EXCITATION Mg 400W

PASS ENERGY= 50

RC= .15 SENS= 2150

DATE 8-13-76 BY DP

8 scans

128 MID

1/4 lev/sec

Figure F-94 - ESCA Graph - Run 21, Location 11, Stage 2, Filter 3043

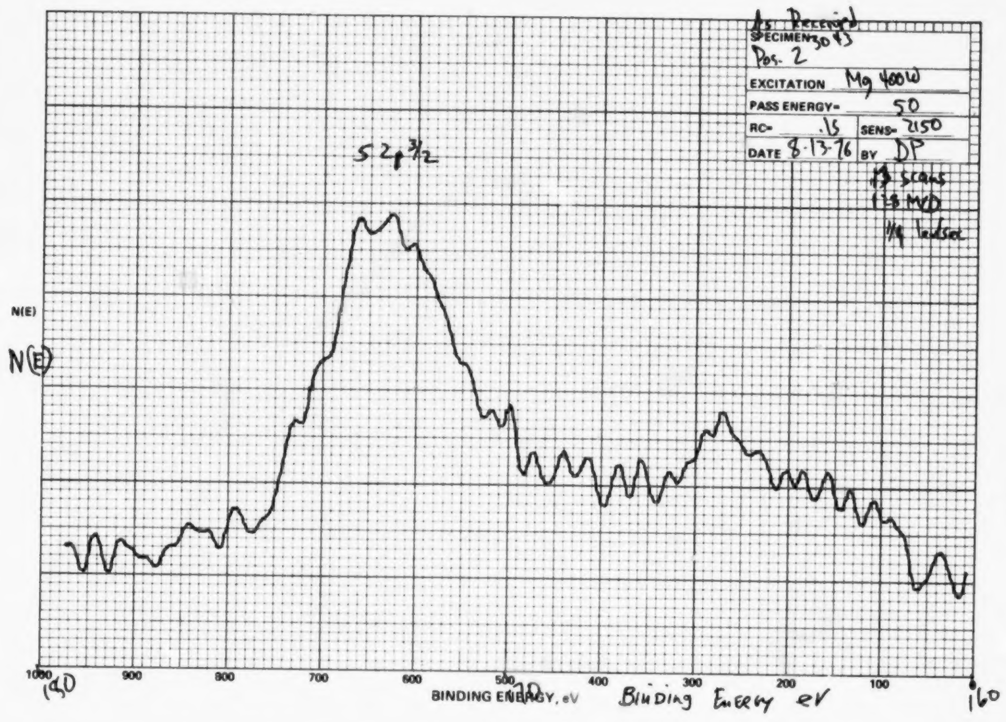


Figure F-95 - ESCA Graph - Run 21, Location 11, Stage 2, Filter 3043

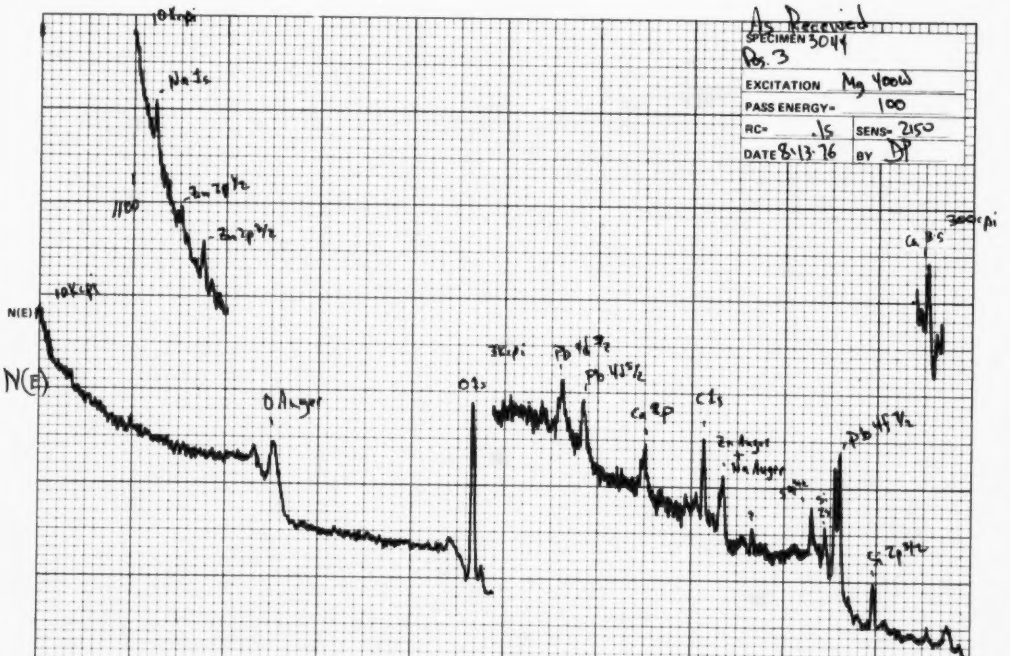


Figure F-96 - ESCA Graph - Run 21, Location 11, Stage 3, Filter 3044

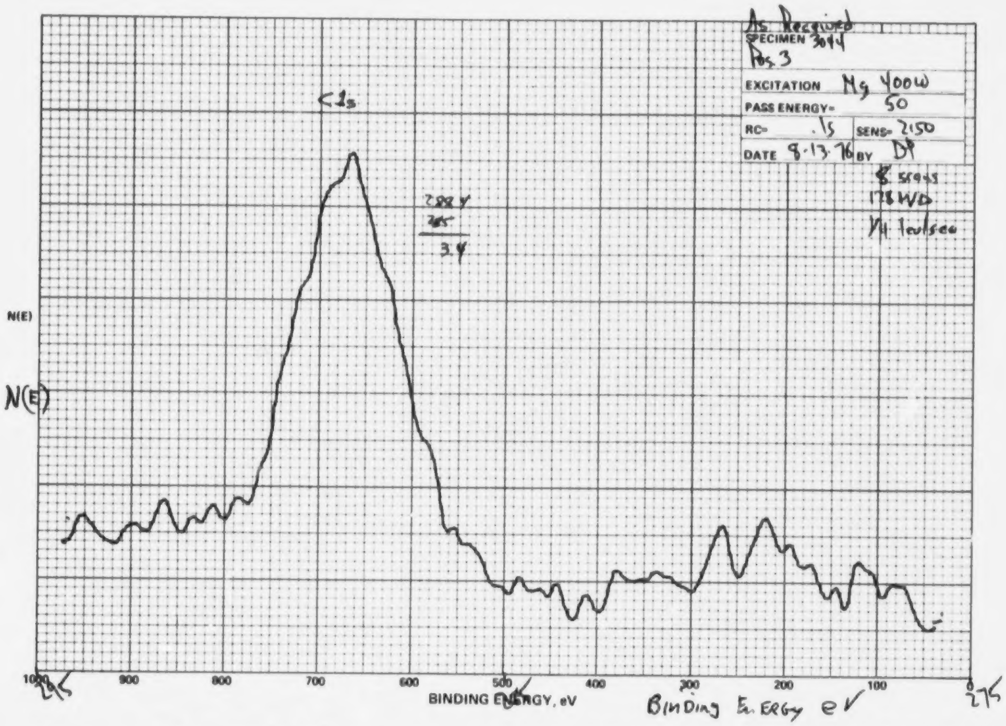


Figure F-97 - ESCA Graph - Run 21, Location 11, Stage 3, Filter 3044

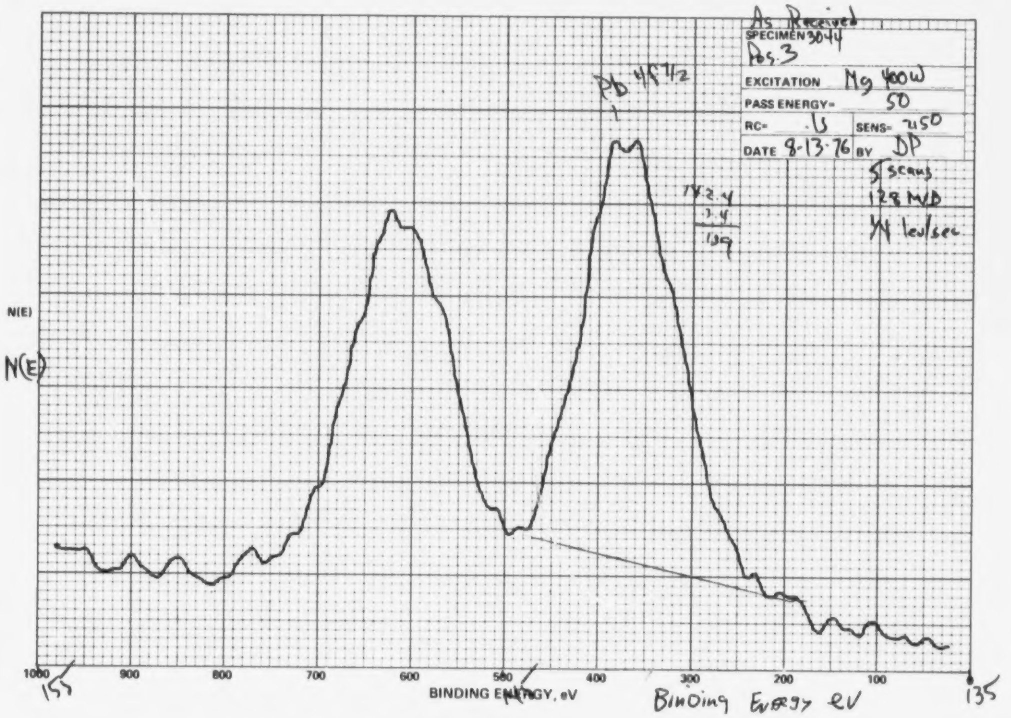


Figure F-98 - ESCA Graph - Run 21, Location 11, Stage 3, Filter 3044

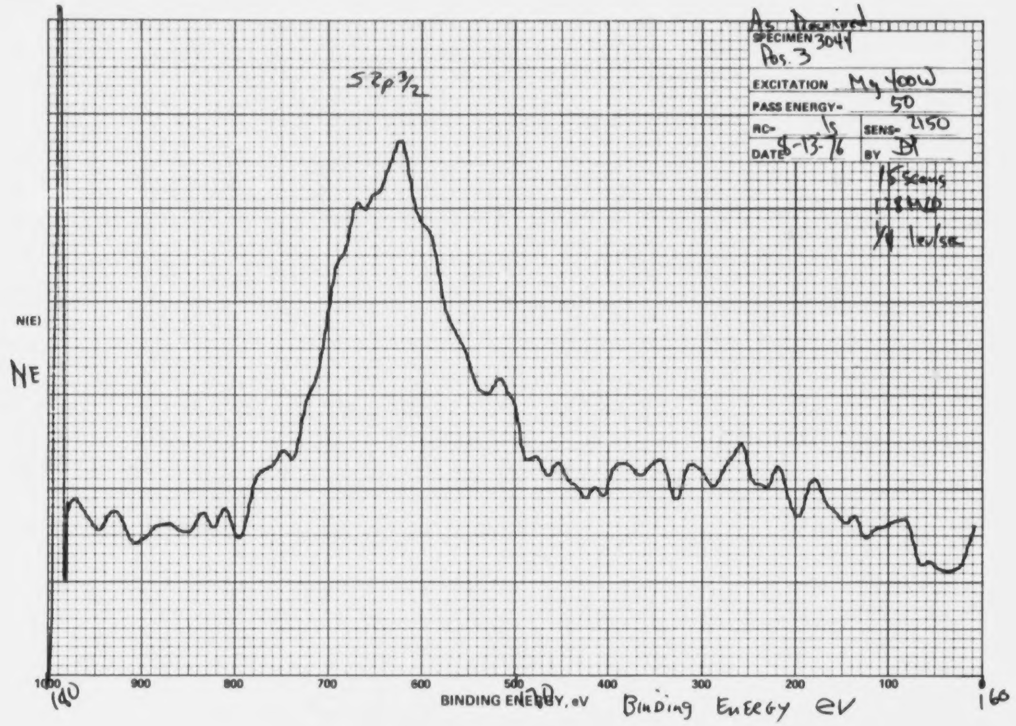


Figure F-99 - ESCA Graph - Run 21, Location 11, Stage 3, Filter 3044

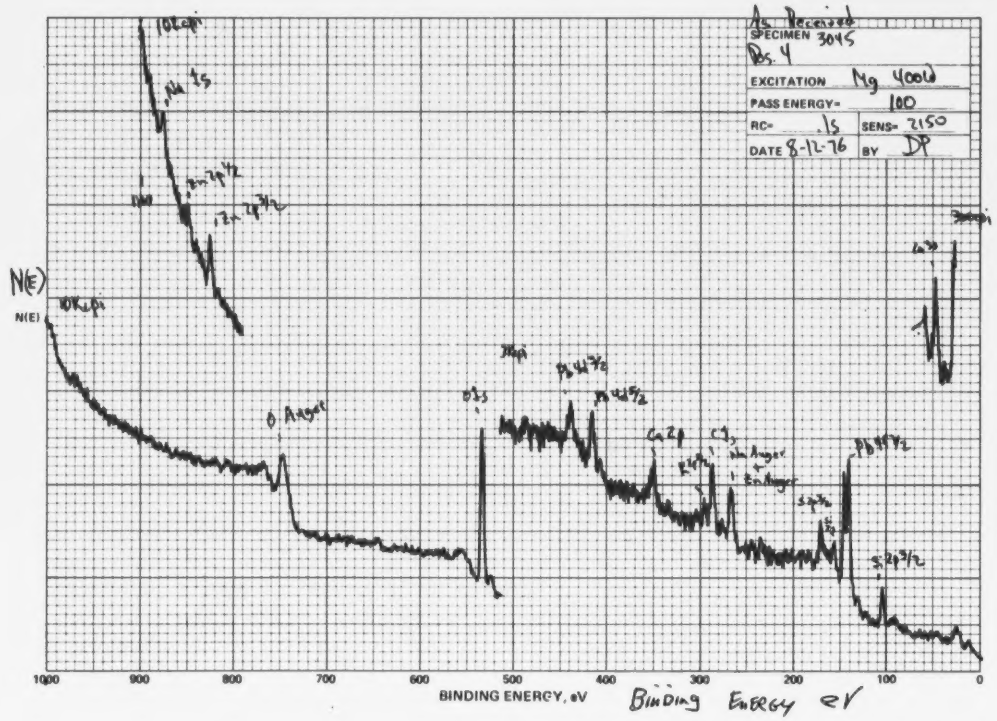
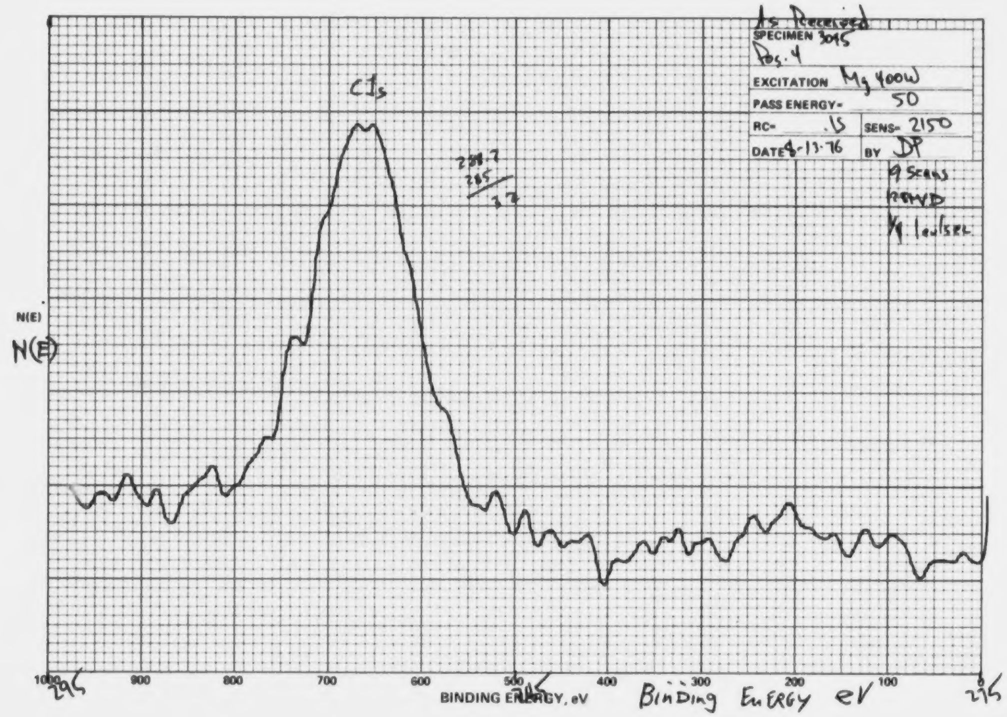
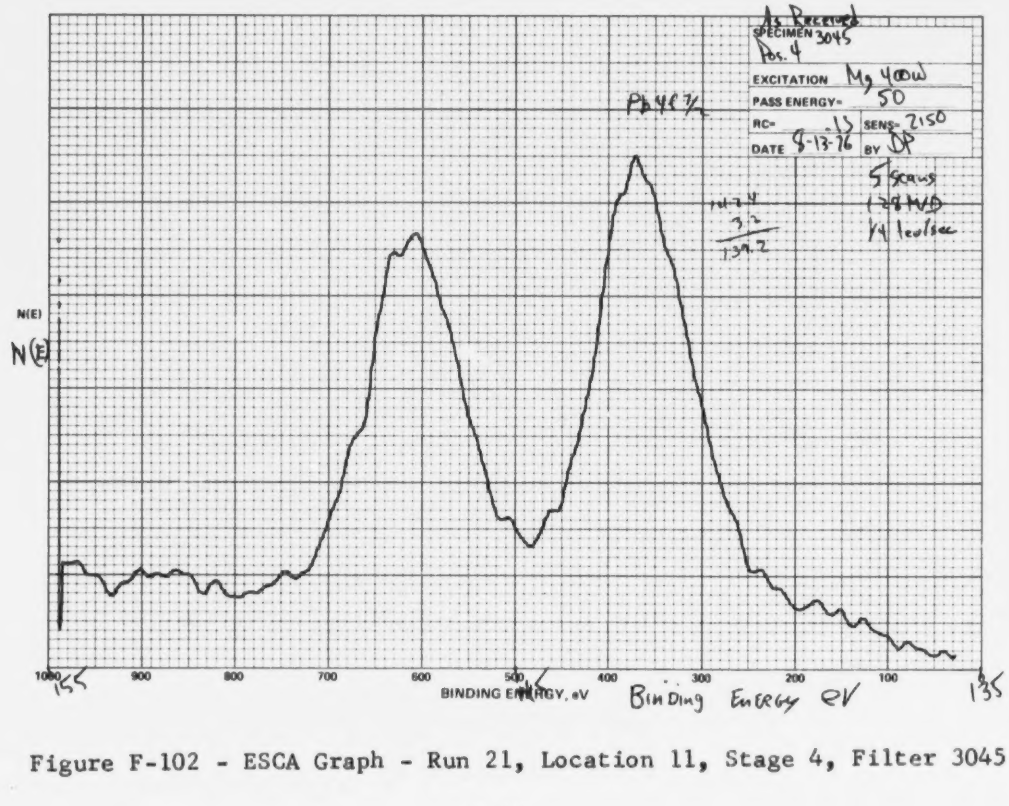


Figure F-100 - ESCA Graph - Run 21, Location 11, Stage 4, Filter 3045



As Received
SPECIMEN 3045
Pos. 4
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .15
SENS= 2150
DATE 8-13-76
BY DP
9 Scans
128MVD
1/4 1ev/sec

Figure F-101 - ESCA Graph - Run 21, Location 11, Stage 4, Filter 3045



As Received
SPECIMEN 3045
Pos. 4
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .15
SENS= 2150
DATE 8-13-76
BY DP
5 Scans
128MVD
1/4 1ev/sec

Figure F-102 - ESCA Graph - Run 21, Location 11, Stage 4, Filter 3045

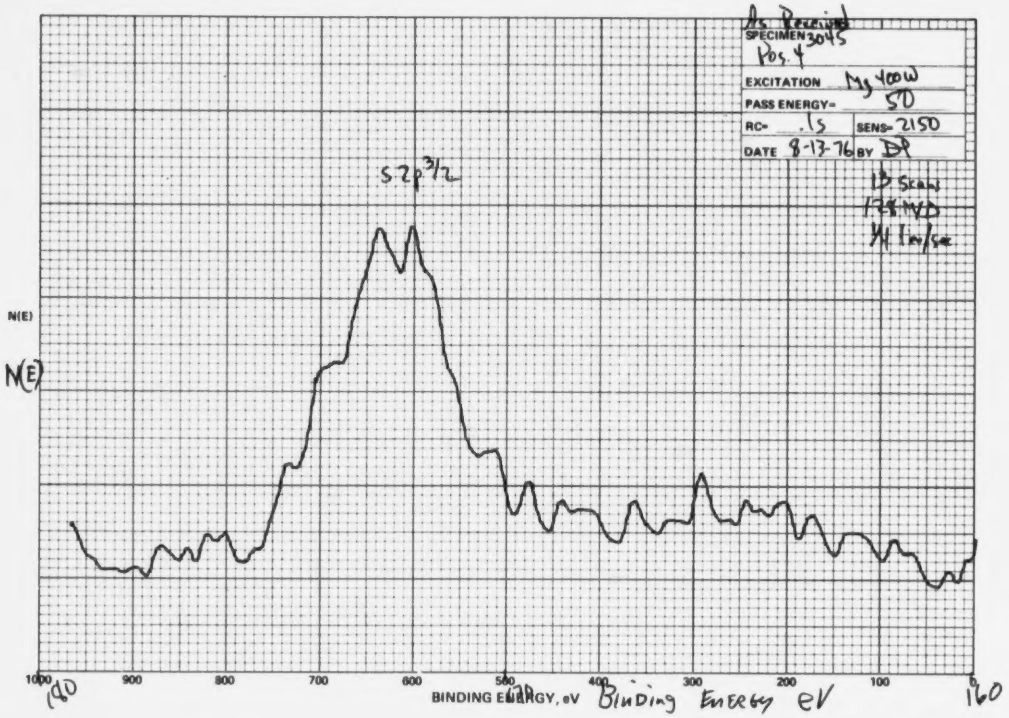


Figure F-103 - ESCA Graph - Run 21, Location 11, Stage 4, Filter 3045

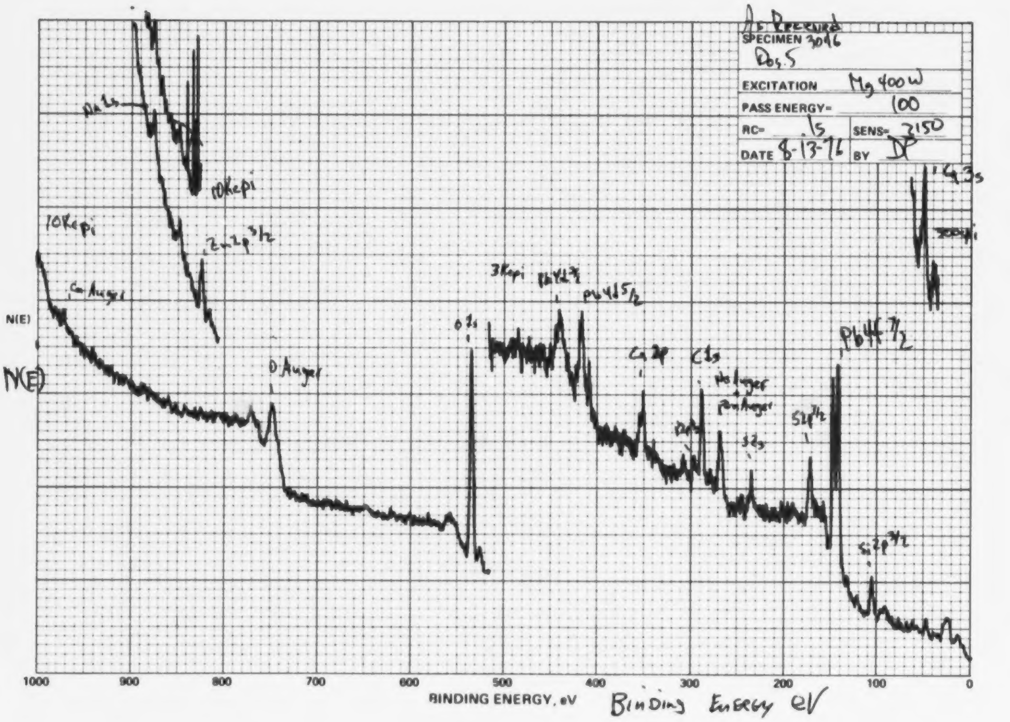


Figure F-104 - ESCA Graph - Run 21, Location 11, Stage 5, Filter 3046

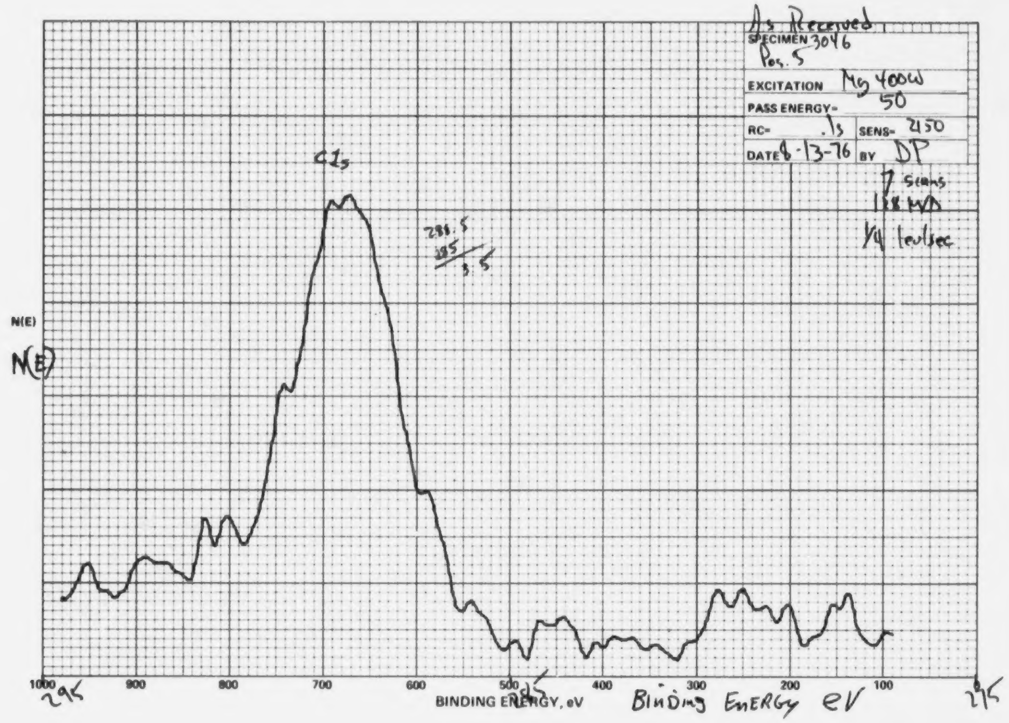


Figure F-105 - ESCA Graph - Run 21, Location 11, Stage 5, Filter 3046

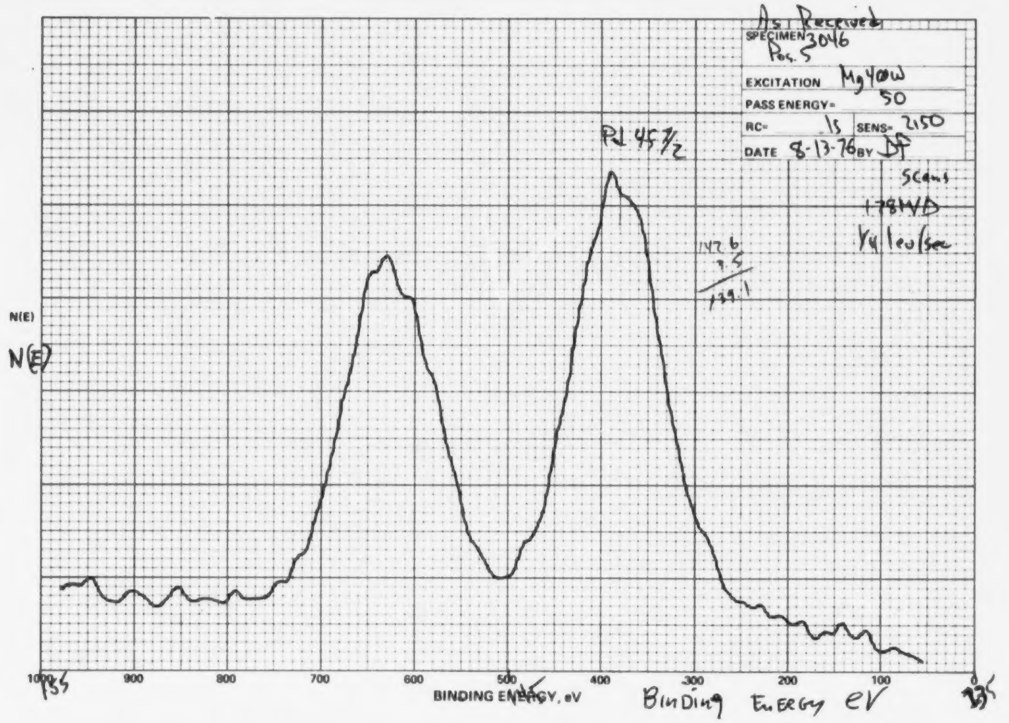


Figure F-106 - ESCA Graph - Run 21, Location 11, Stage 5, Filter 3046

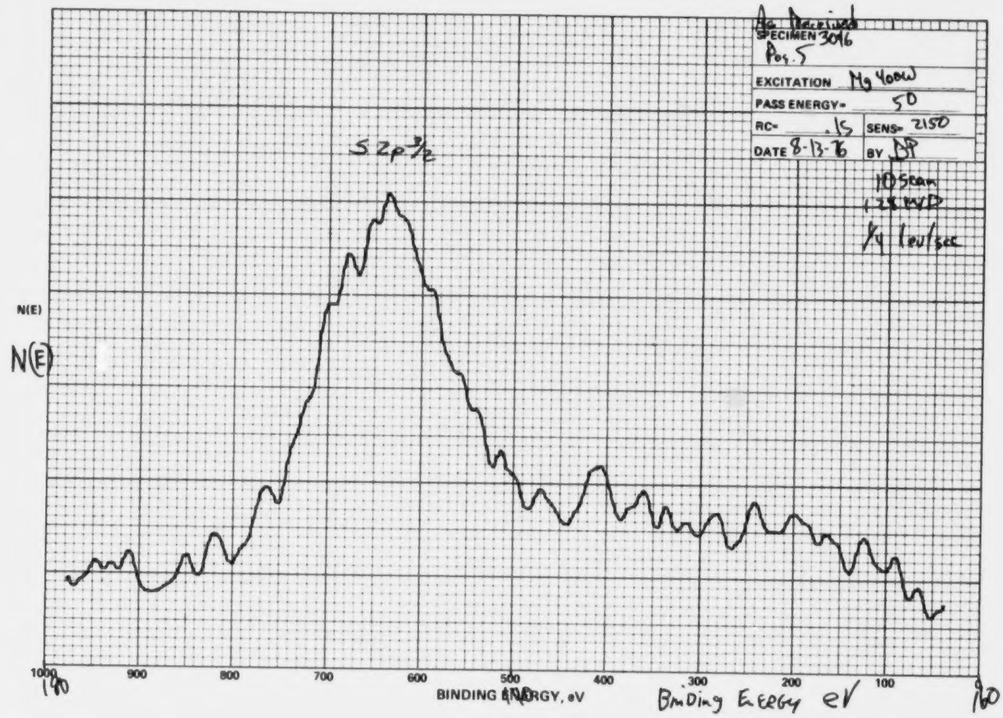


Figure F-107 - ESCA Graph - Run 21, Location 11, Stage 5, Filter 3046

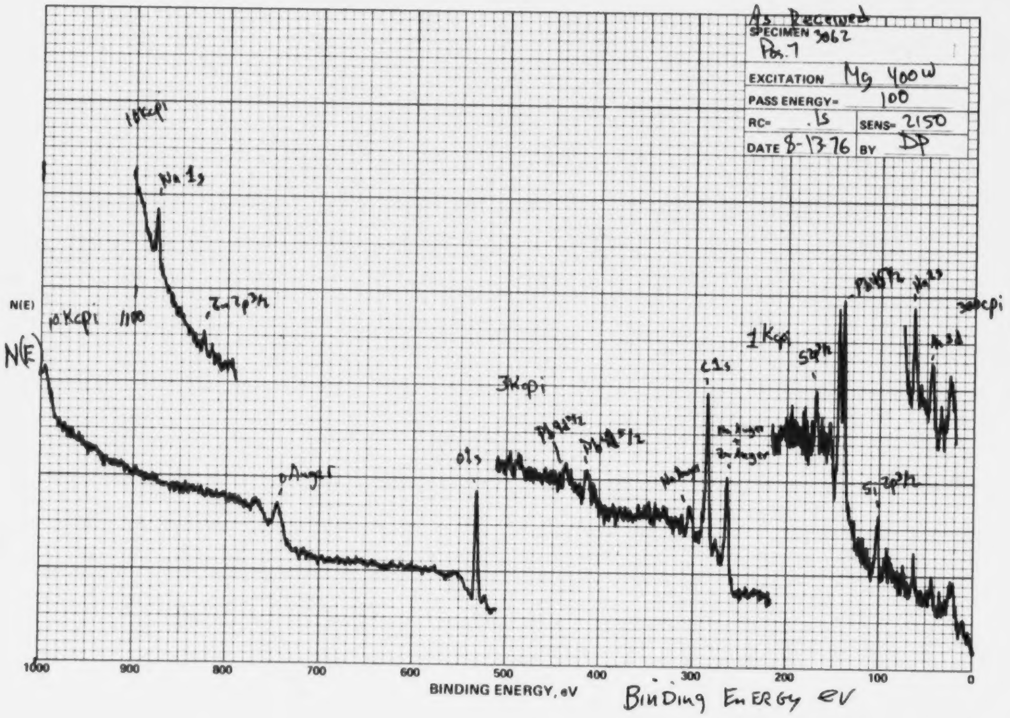


Figure F-108 - ESCA Graph - Run 29, Location 17, Stage 1, Filter 3062

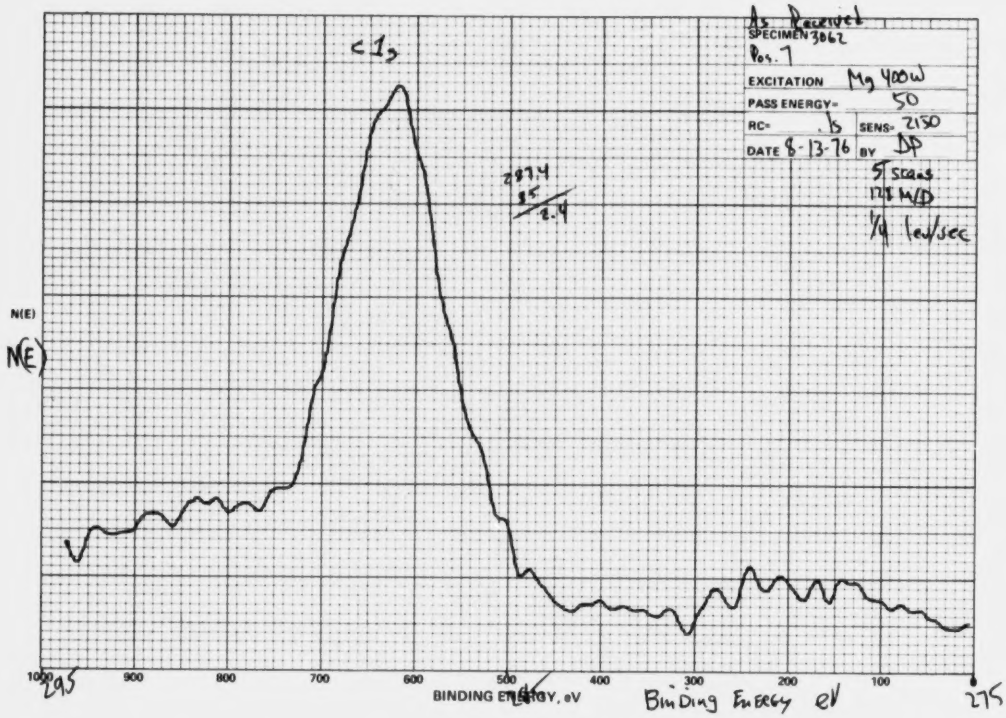


Figure F-109 - ESCA Graph - Run 29, Location 17, Stage 1, Filter 3062

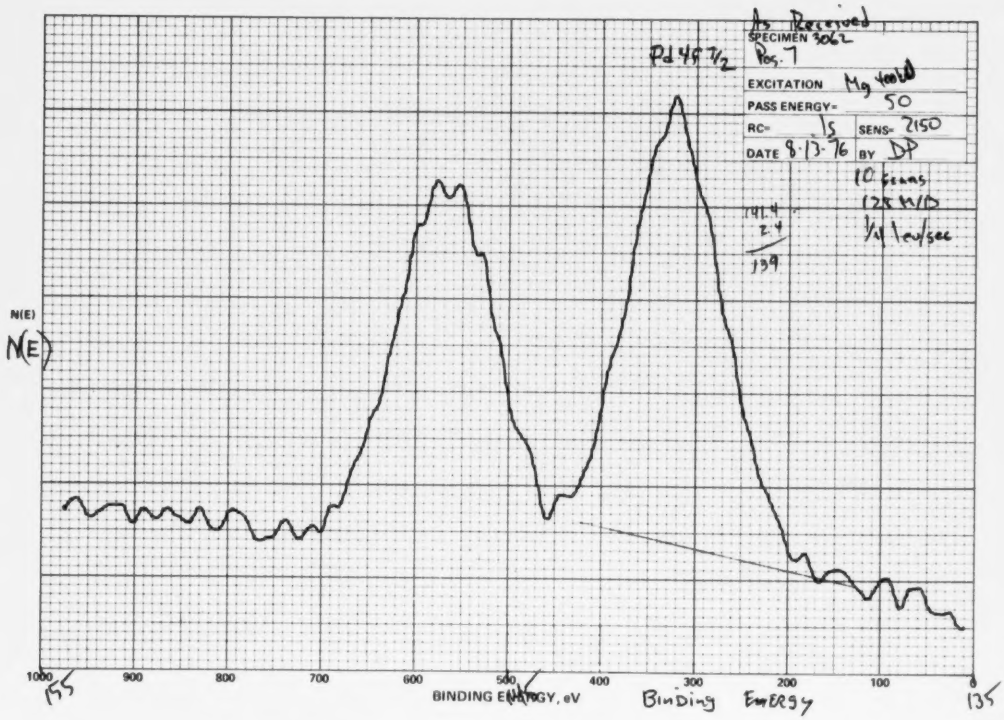


Figure F-110 - ESCA Graph - Run 29, Location 17, Stage 1, Filter 3062

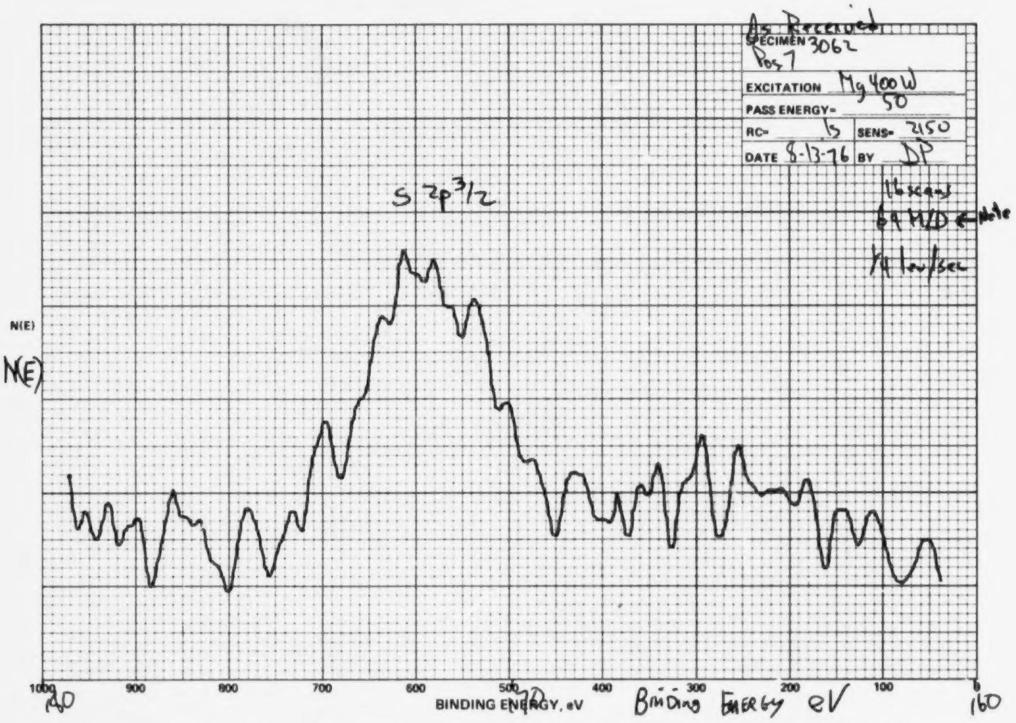


Figure F-111 - ESCA Graph - Run 29, Location 17, Stage 1, Filter 3062

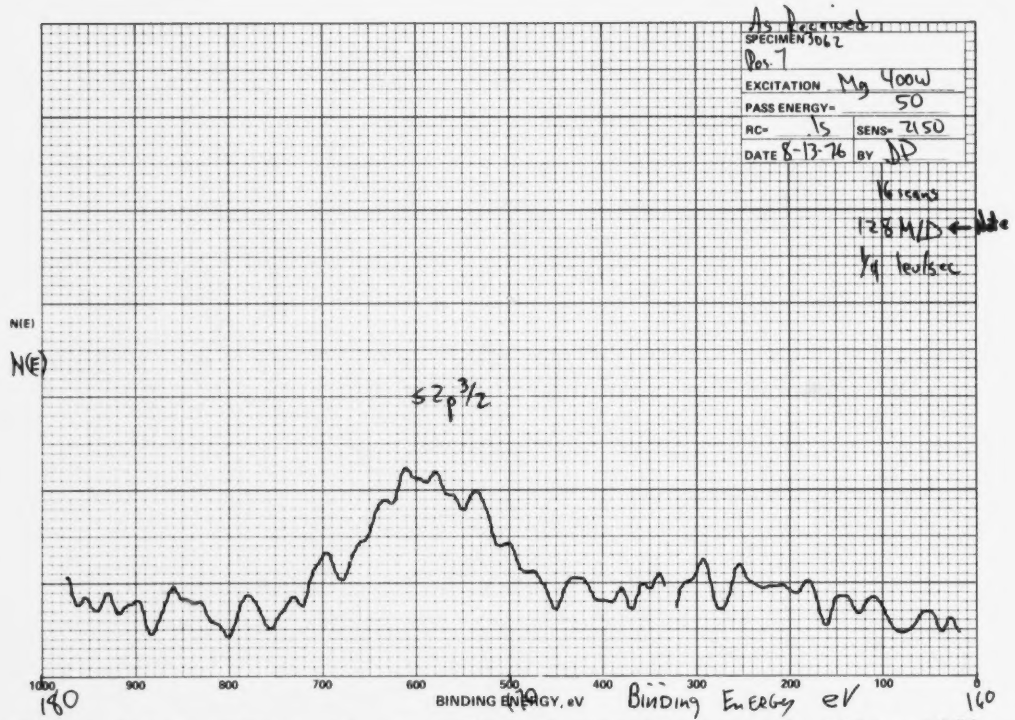
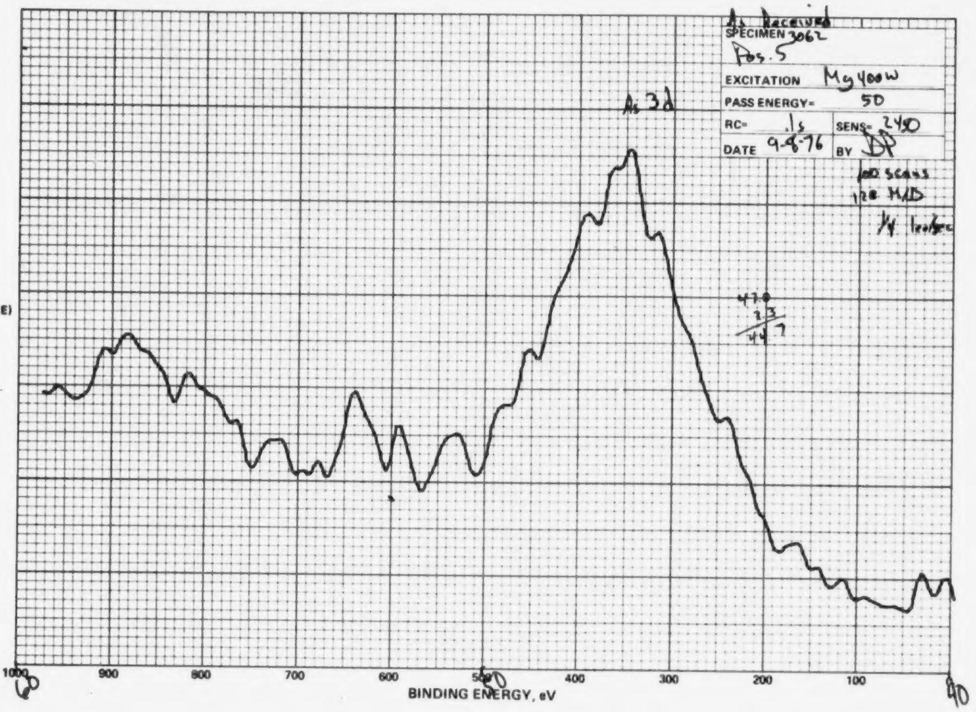


Figure F-112- ESCA Graph - Run 29, Location 17, Stage 1, Filter 3062


As Received
SPECIMEN 3062
Pos. 5
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .1s
SENS= 2450
DATE 9-8-76
BY DP

100 scans
128 M/D
1/4 [illegible]

Figure F-113 - ESCA Graph - Run 29, Location 17, Stage 1, Filter 3062

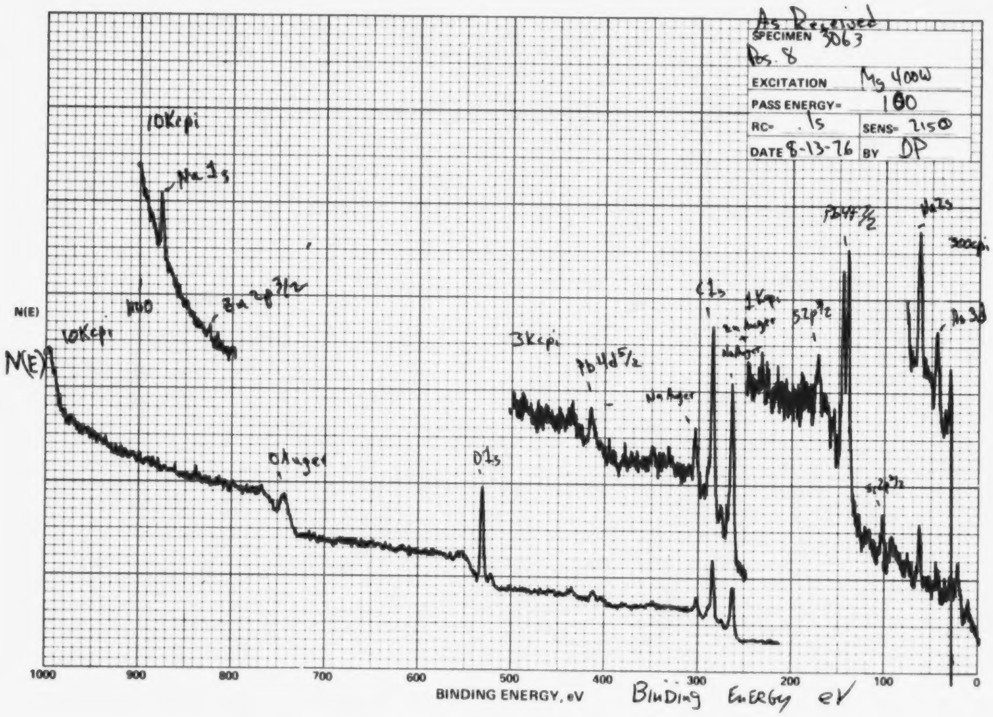

As Received
SPECIMEN 3063
Pos. 8
EXCITATION Mg 400W
PASS ENERGY= 100
RC= .1s
SENS= 2150
DATE 8-13-76
BY DP

Figure F-114 - ESCA Graph - Run 29, Location 17, Stage 2, Filter 3063

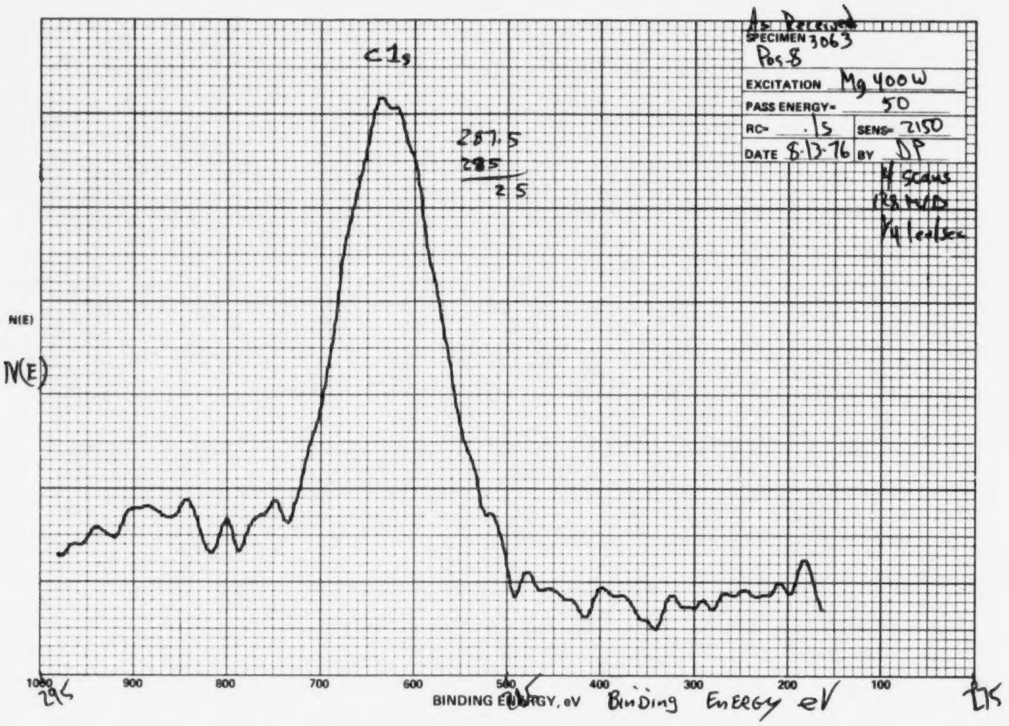


Figure F-115 - ESCA Graph - Run 29, Location 17, Stage 2, Filter 3063

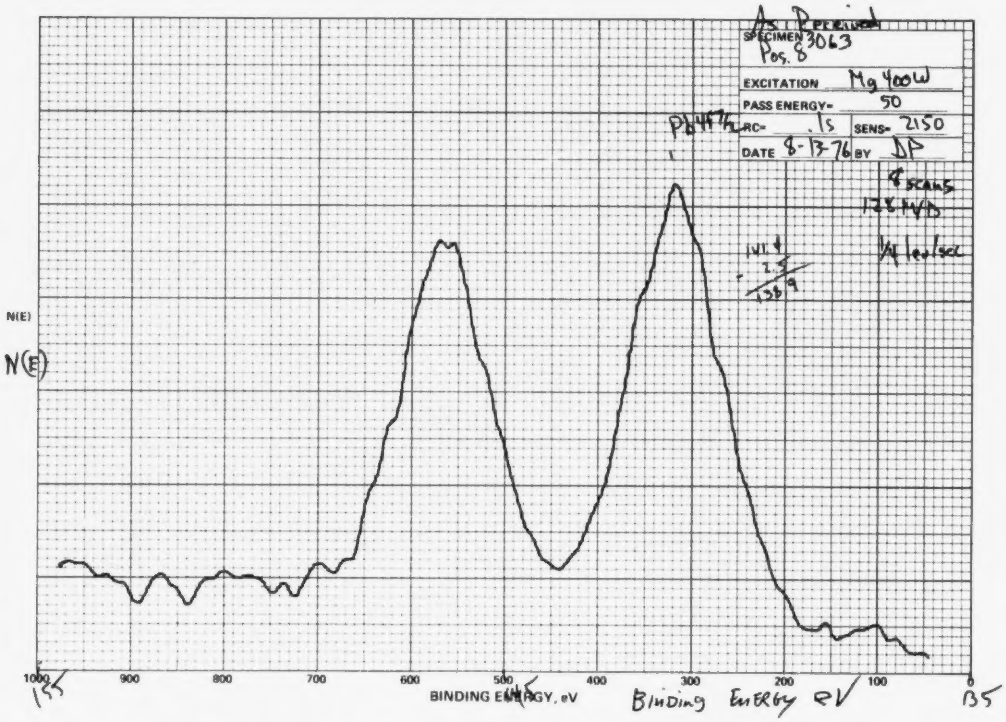


Figure F-116 - ESCA Graph - Run 29, Location 17, Stage 2, Filter 3063

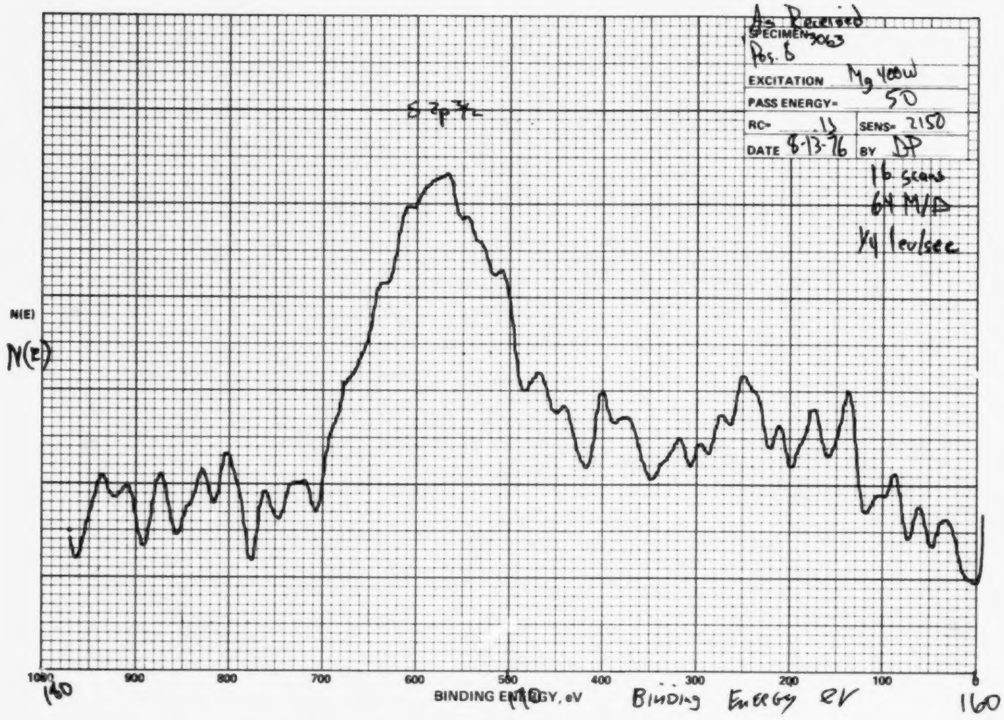


Figure F-117 - ESCA Graph - Run 29, Location 17, Stage 2, Filter 3063

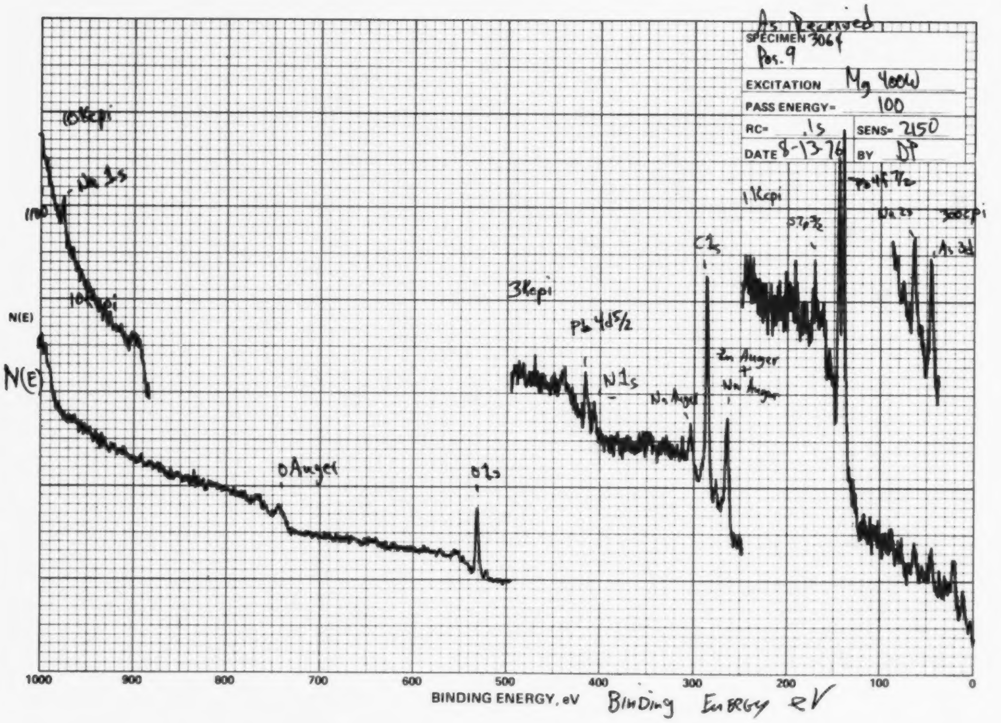


Figure F-118 - ESCA Graph - Run 29, Location 17, Stage 3, Filter 3064

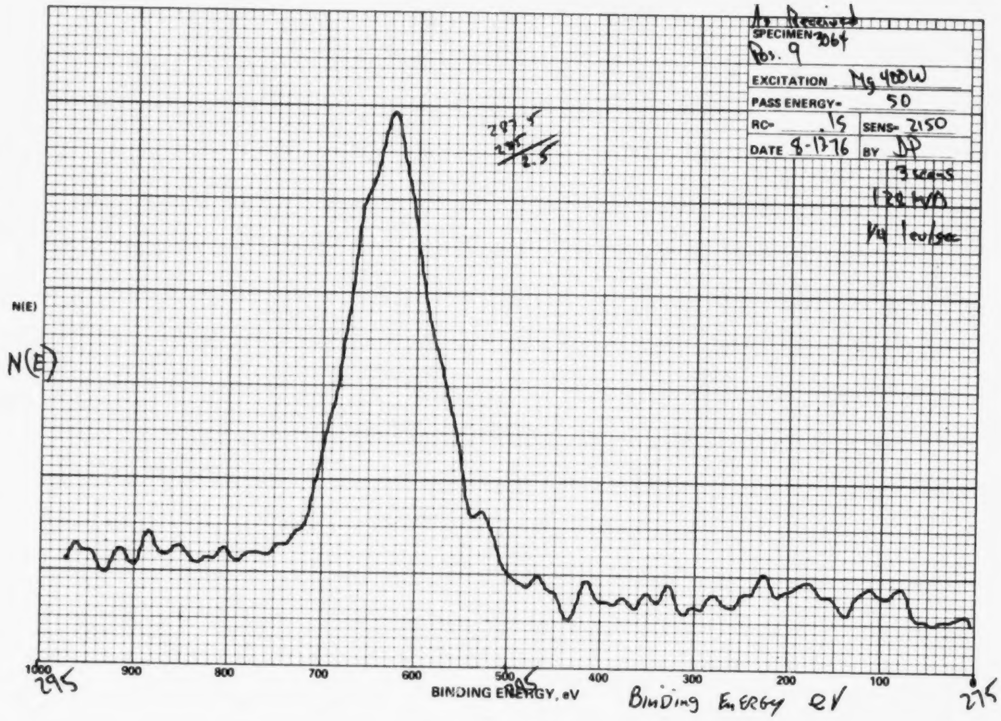


Figure F-119 - ESCA Graph - Run 29, Location 17, Stage 3, Filter 3064

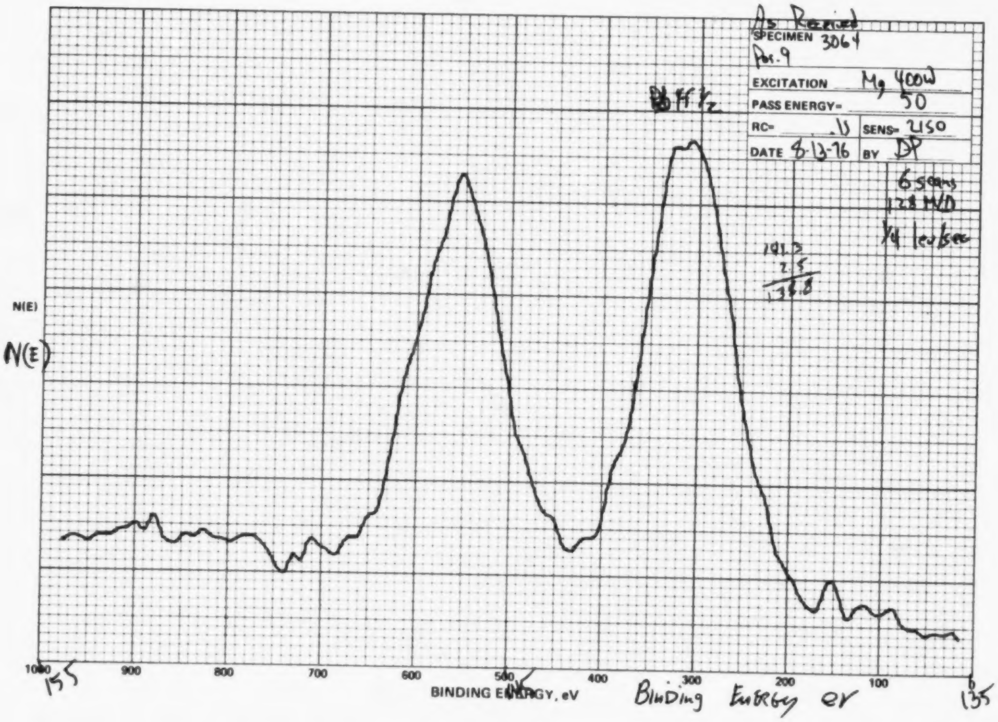


Figure F-120 - ESCA Graph - Run 29, Location 17, Stage 3, Filter 3064

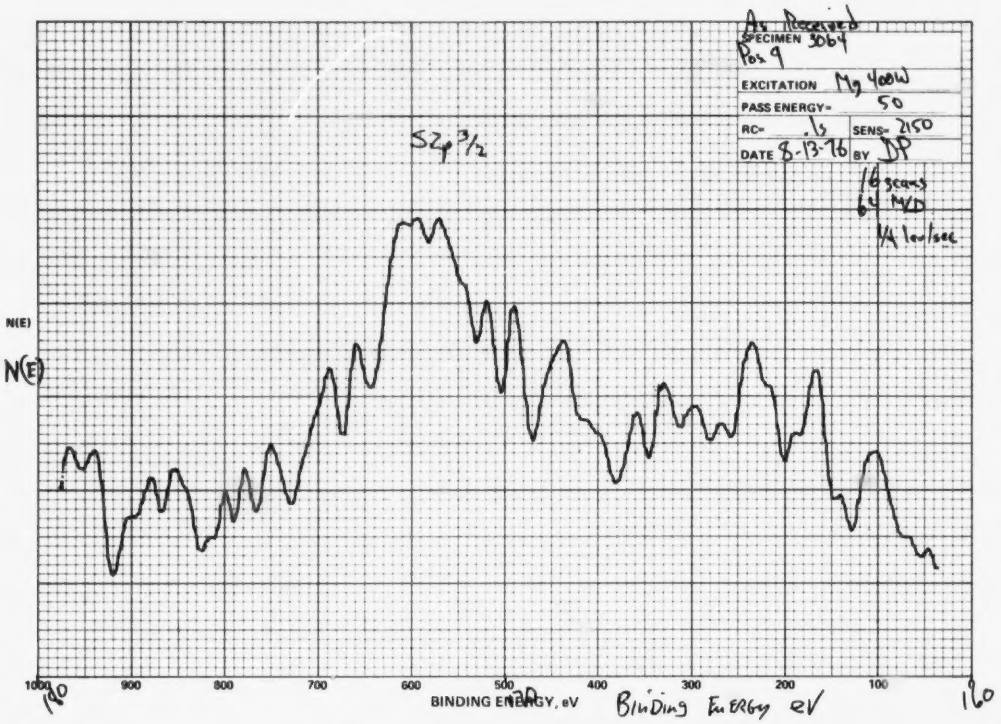


Figure F-121 - ESCA Graph - Run 29, Location 17, Stage 3, Filter 3064

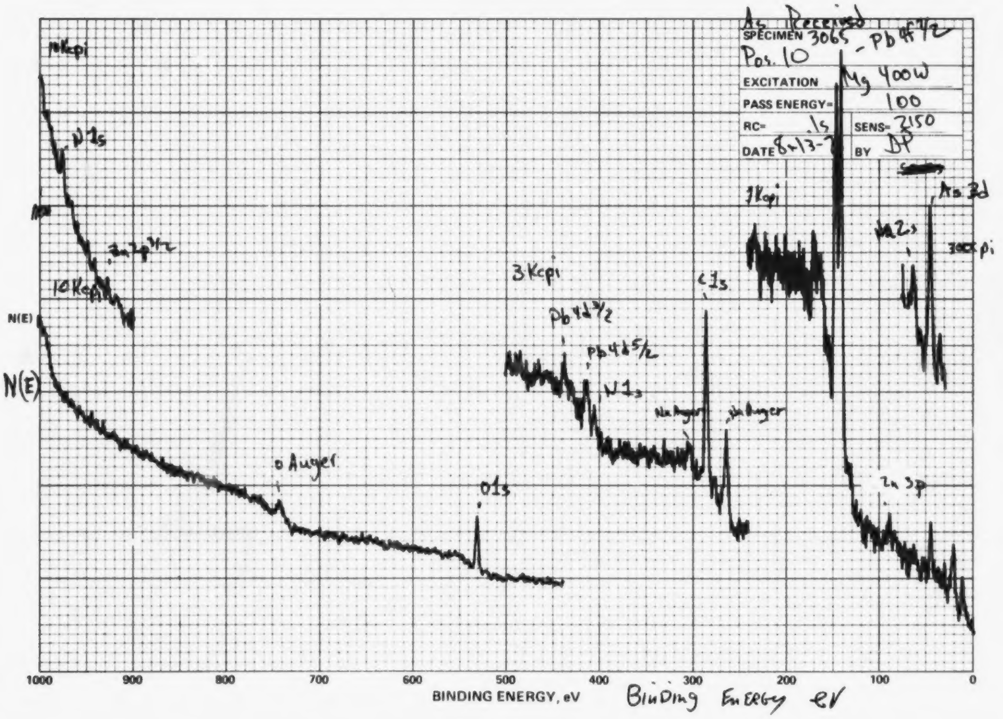


Figure F-122 - ESCA Graph - Run 29, Location 17, Stage 4, Filter 3065

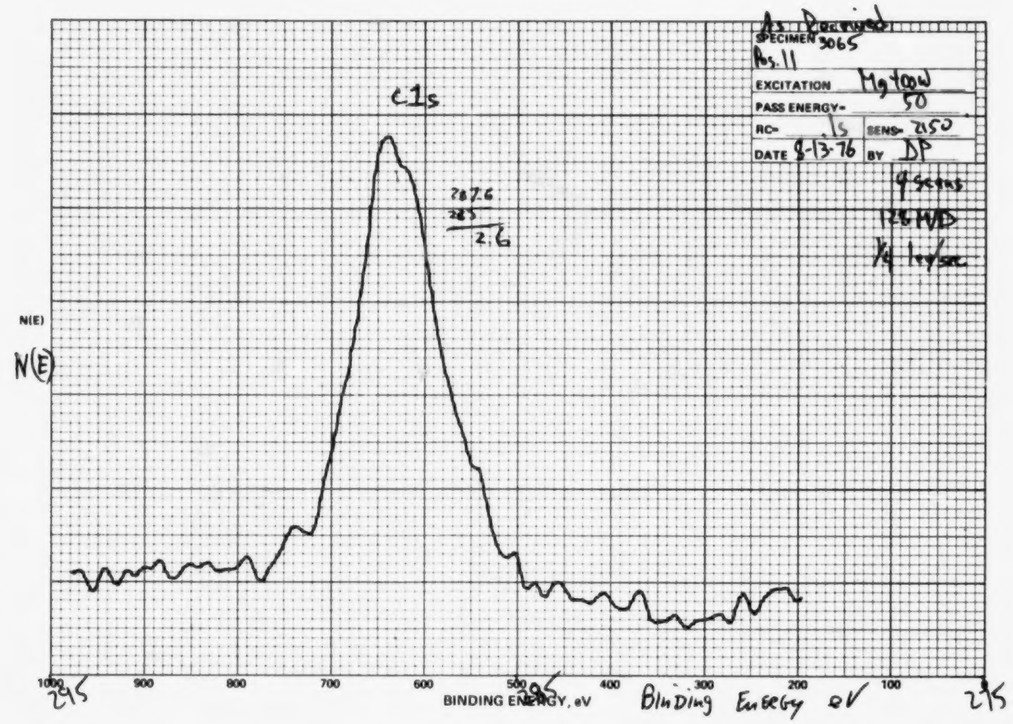


Figure F-123 - ESCA Graph - Run 29, Location 17, Stage 4, Filter 3065

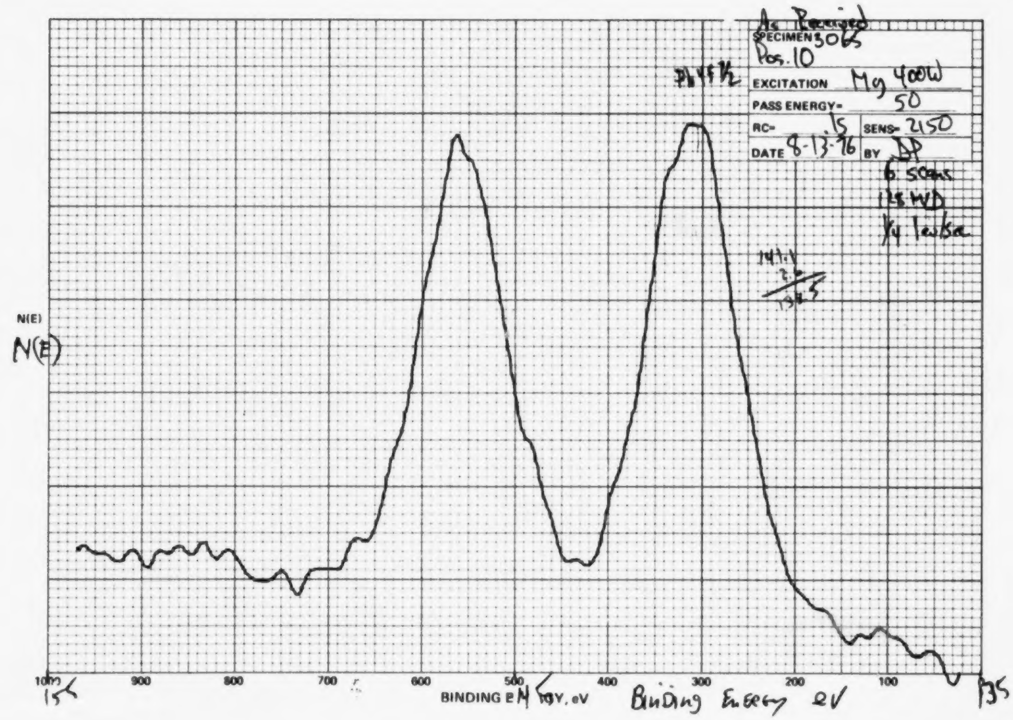


Figure F-124 - ESCA Graph - Run 29, Location 17, Stage 4, Filter 3065

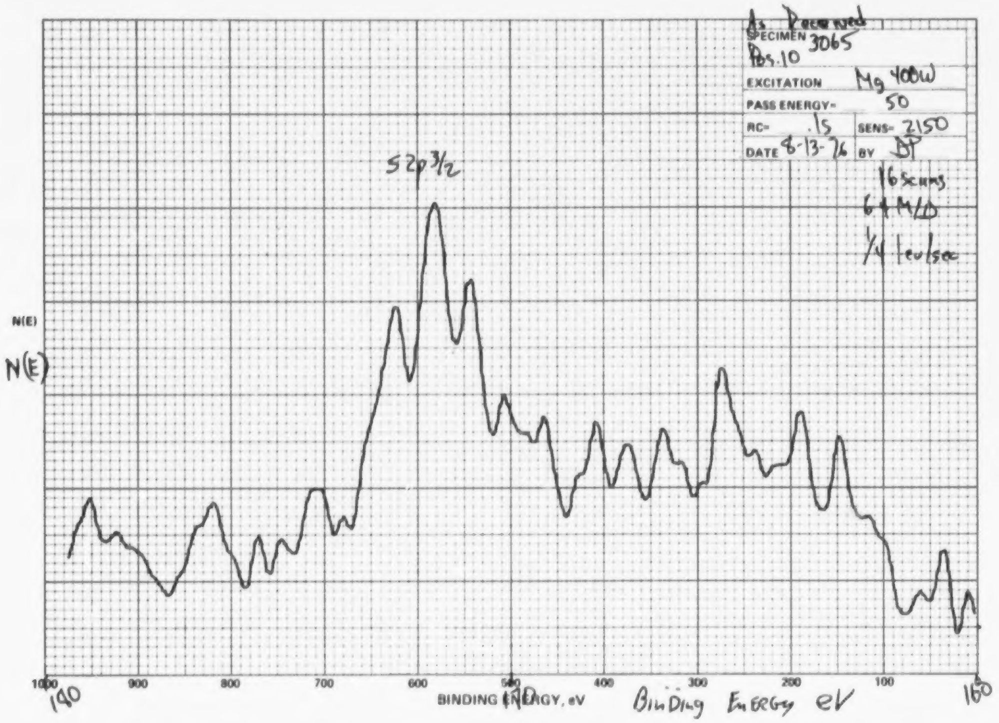


Figure F-125 - ESCA Graph - Run 29, Location 17, Stage 4, Filter 3065

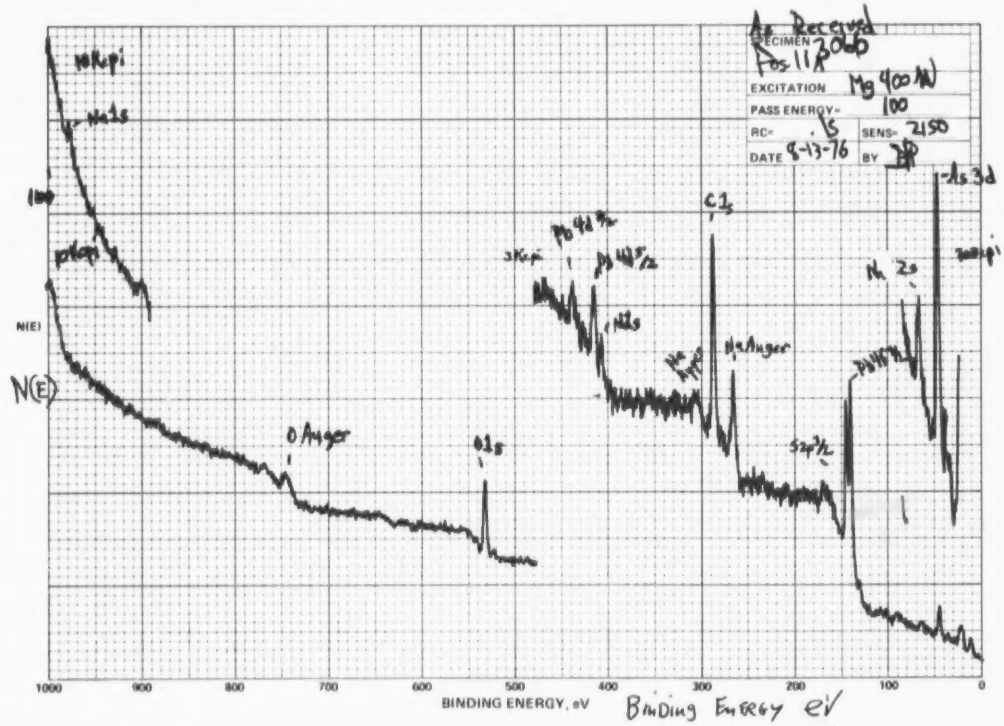


Figure F-126 - ESCA Graph - Run 29, Location 17, Stage 5, Filter 3066

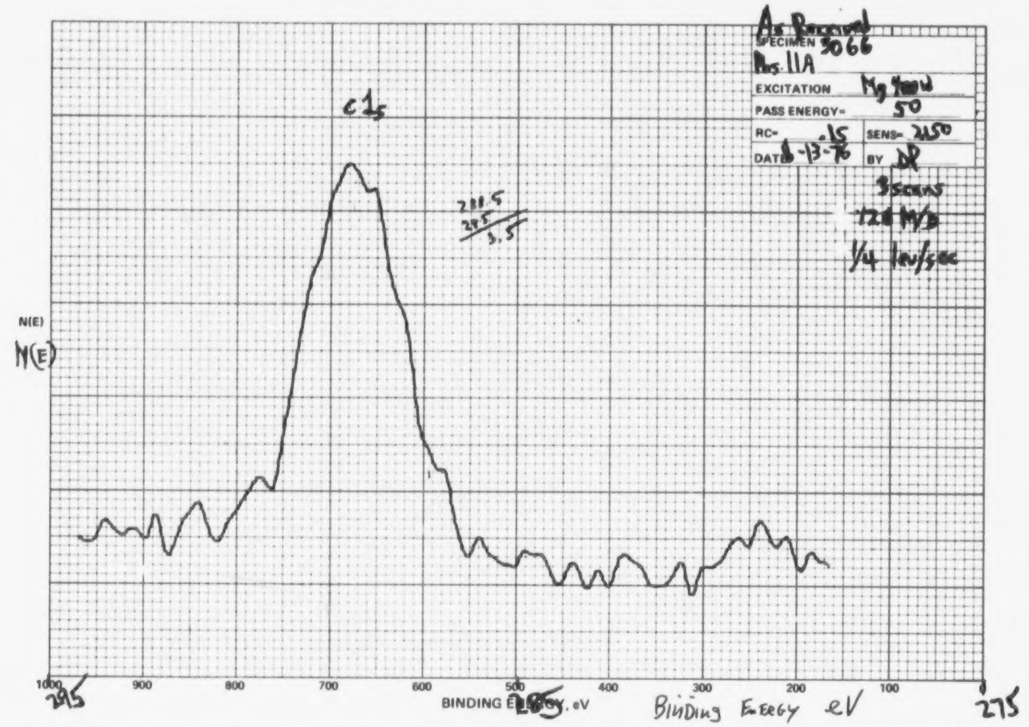


Figure F-127 - ESCA Graph - Run 29, Location 17, Stage 5, Filter 3066

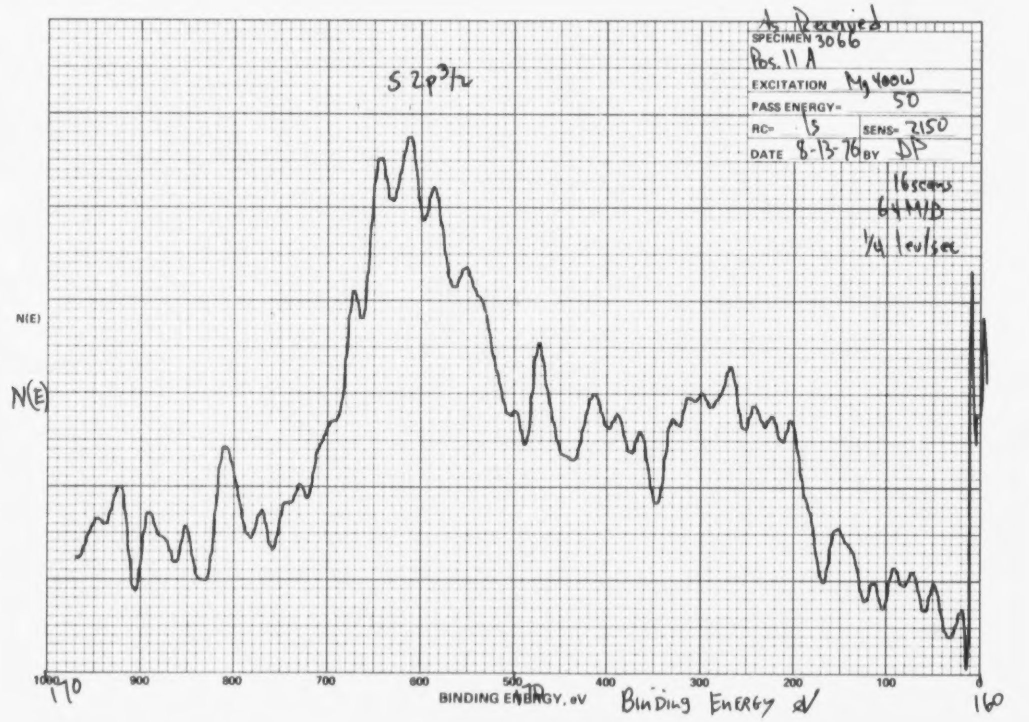


Figure F-128 - ESCA Graph - Run 29, Location 17, Stage 5, Filter 3066

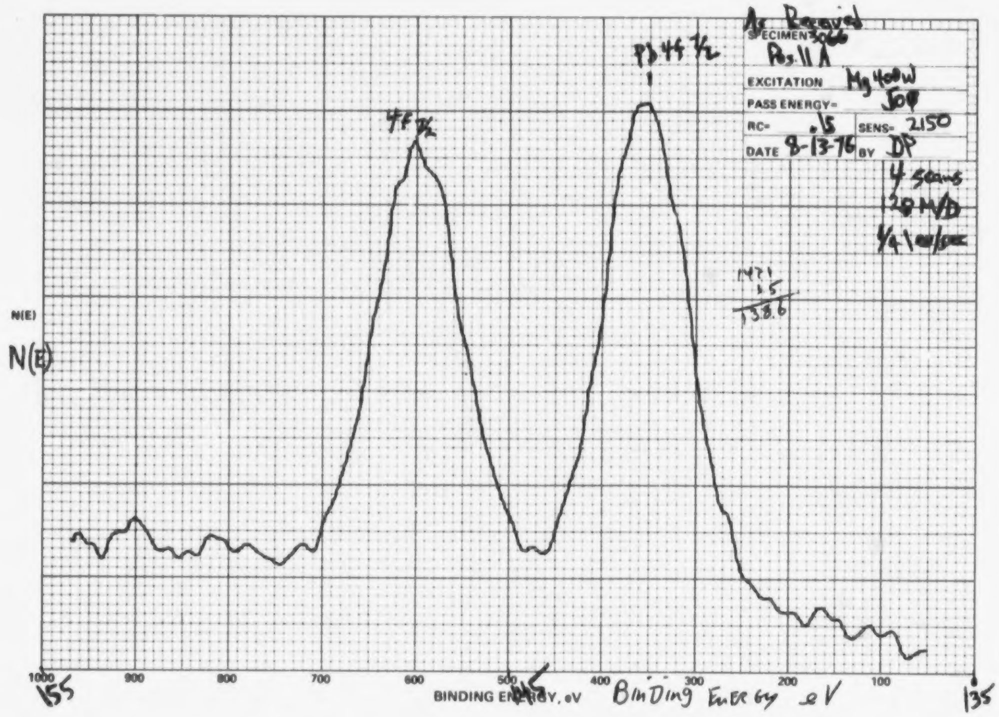


Figure F-129 - ESCA Graph - Run 29, Location 17, Stage 5, Filter 3066

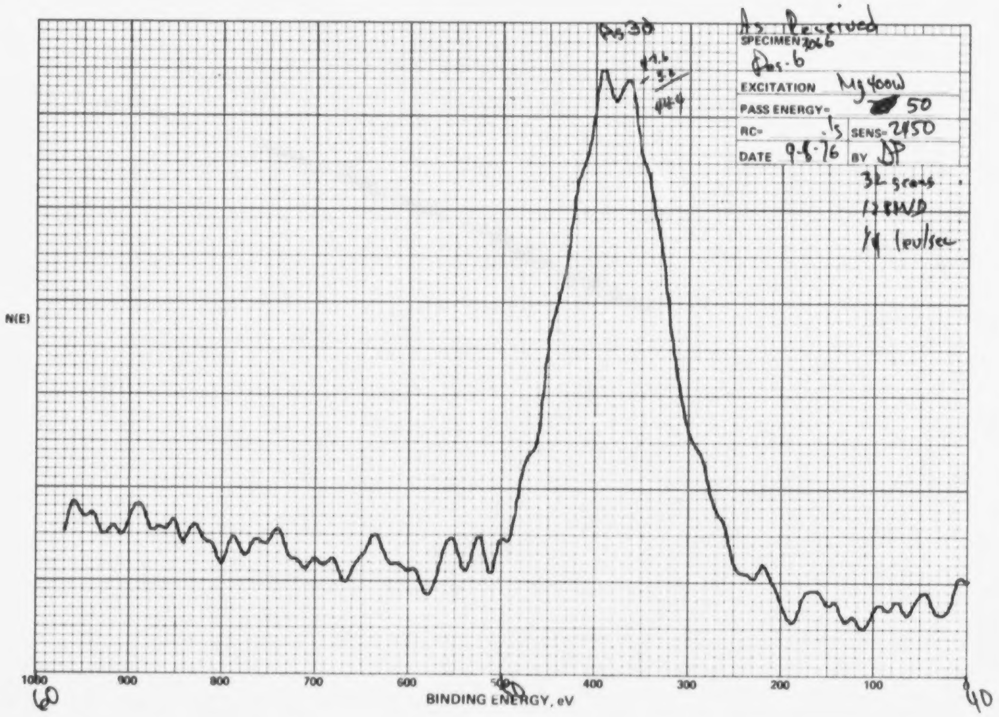


Figure F-130 - ESCA Graph - Run 29, Location 17, Stage 5, Filter 3066

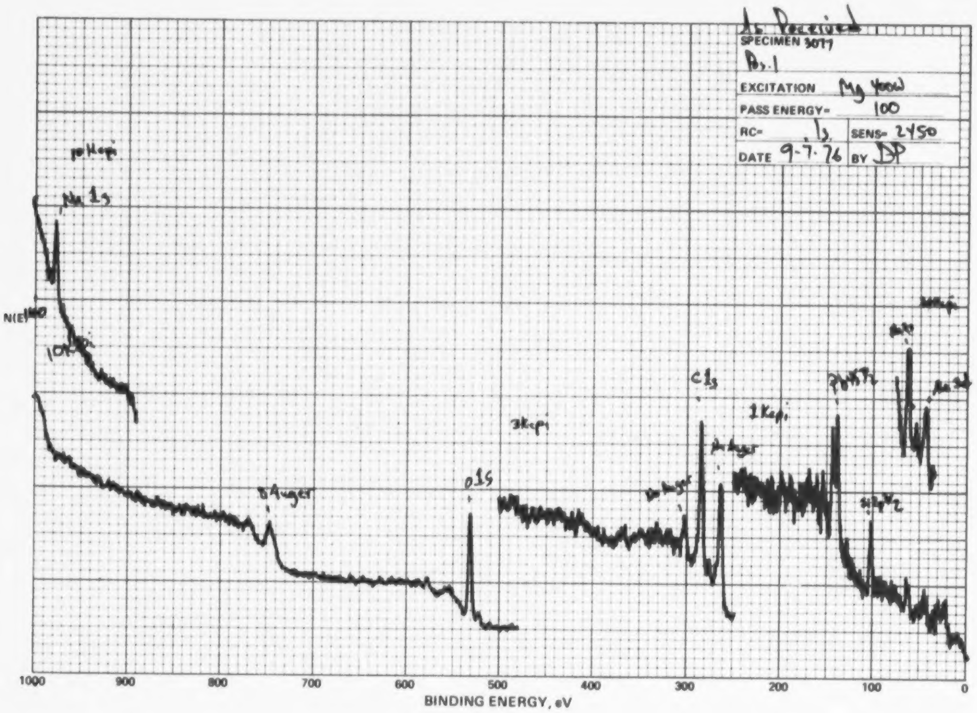


Figure F-131 - ESCA Graph - Run 31, Location 18, Stage 1, Filter 3077

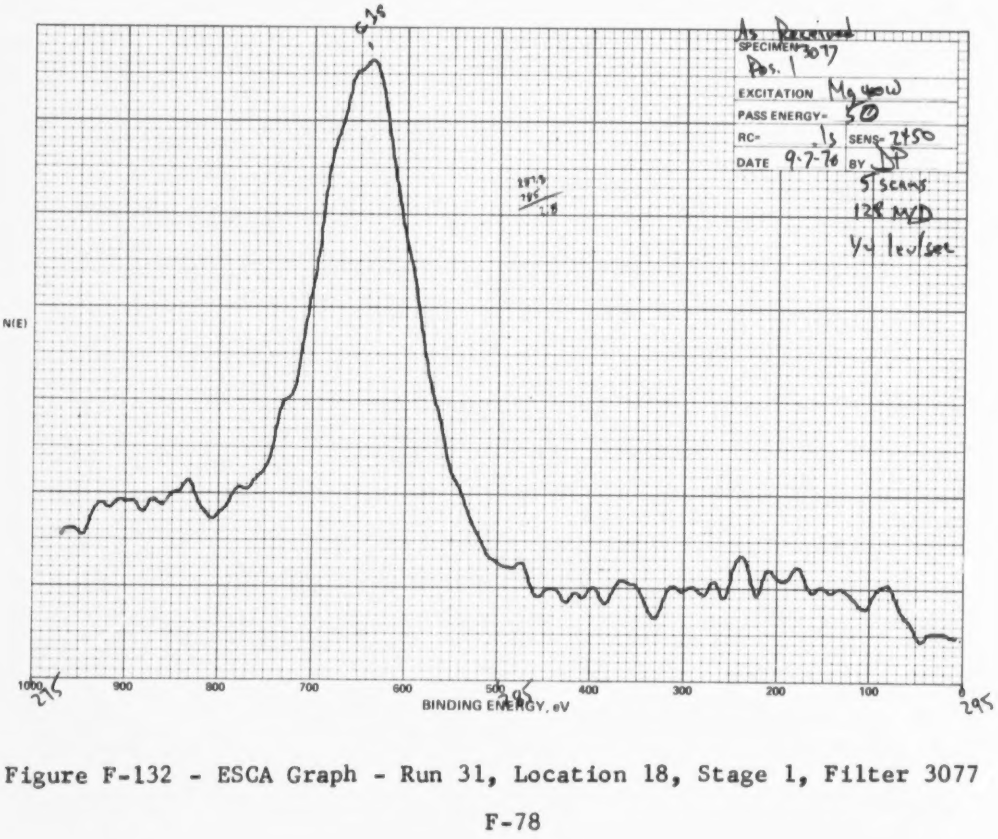


Figure F-132 - ESCA Graph - Run 31, Location 18, Stage 1, Filter 3077

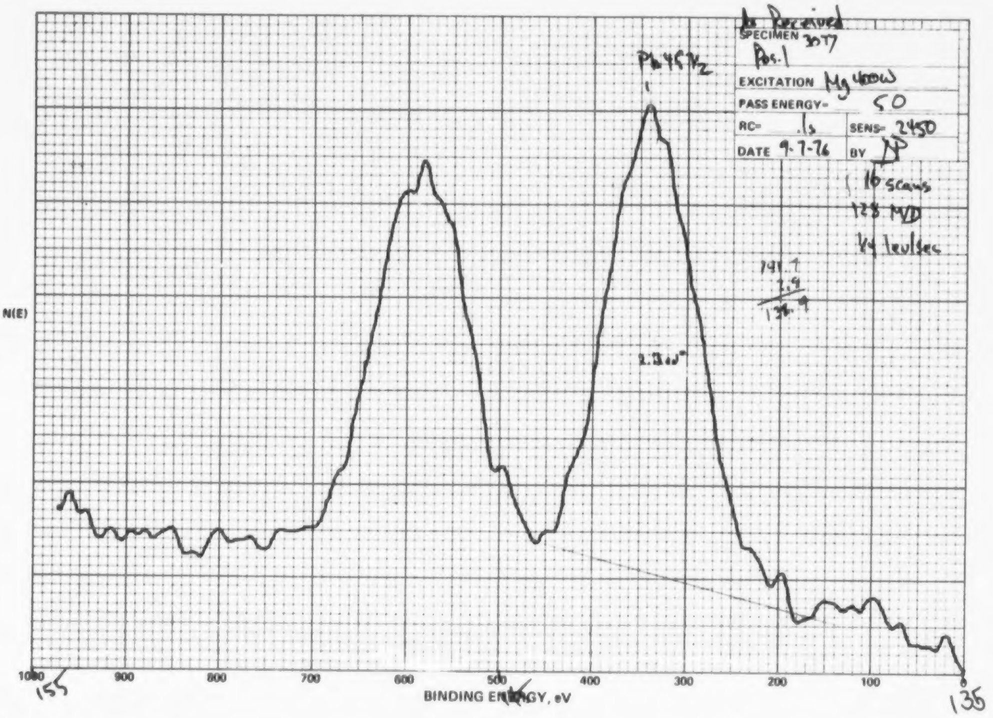


Figure F-133 - ESCA Graph - Run 31, Location 18, Stage 1, Filter 3077

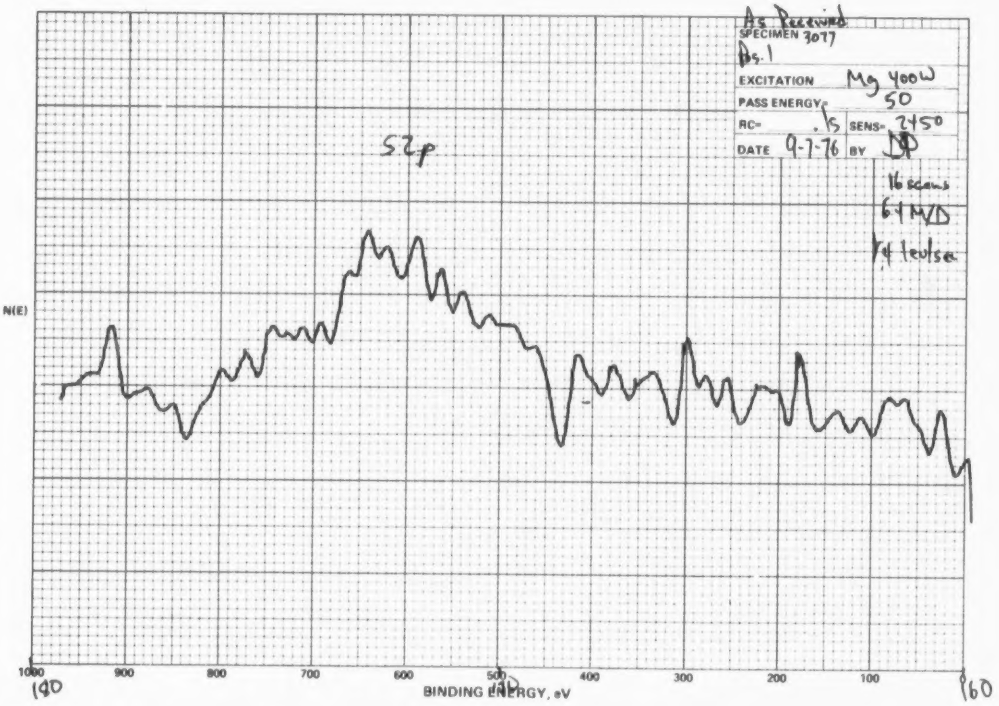


Figure F-134 - ESCA Graph - Run 31, Location 18, Stage 1, Filter 3077

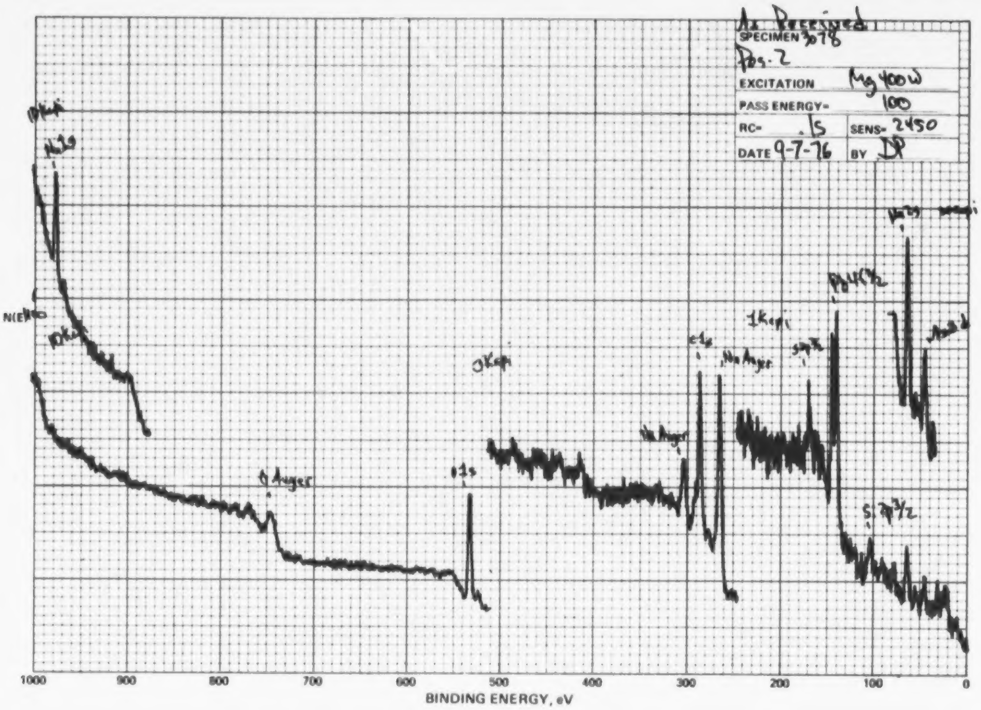


Figure F-135 - ESCA Graph - Run 31, Location 18, Stage 2, Filter 3078

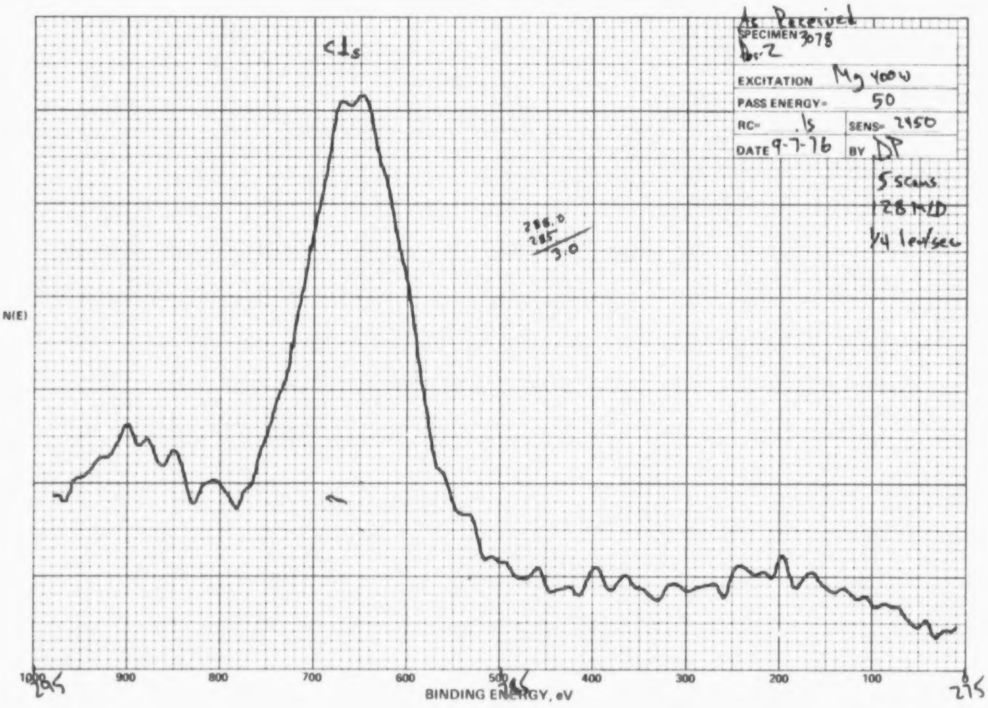
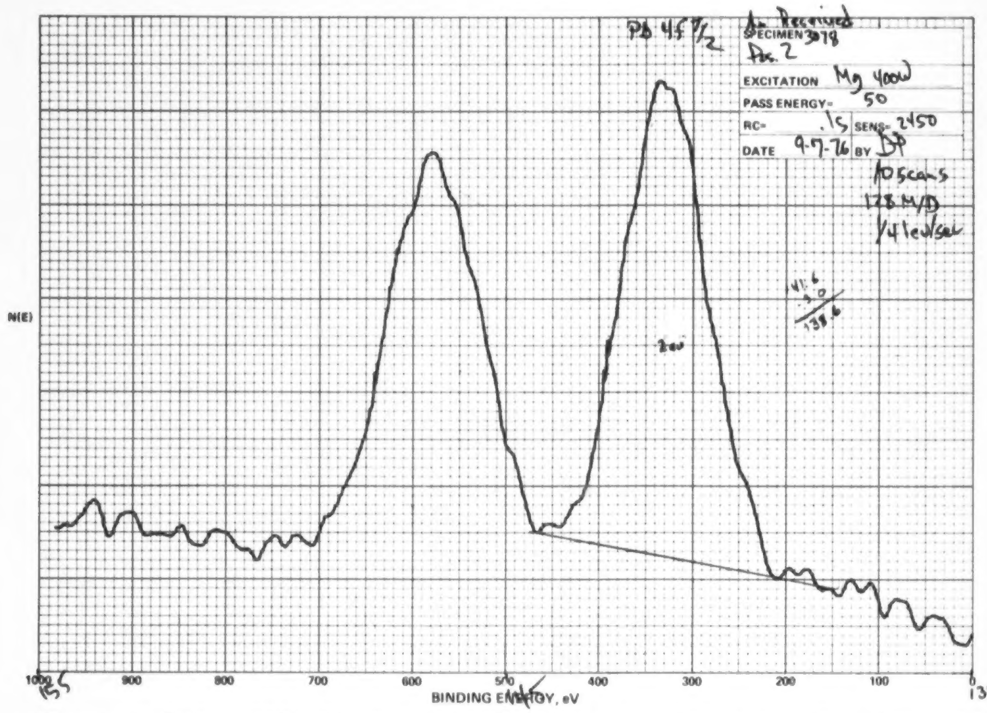
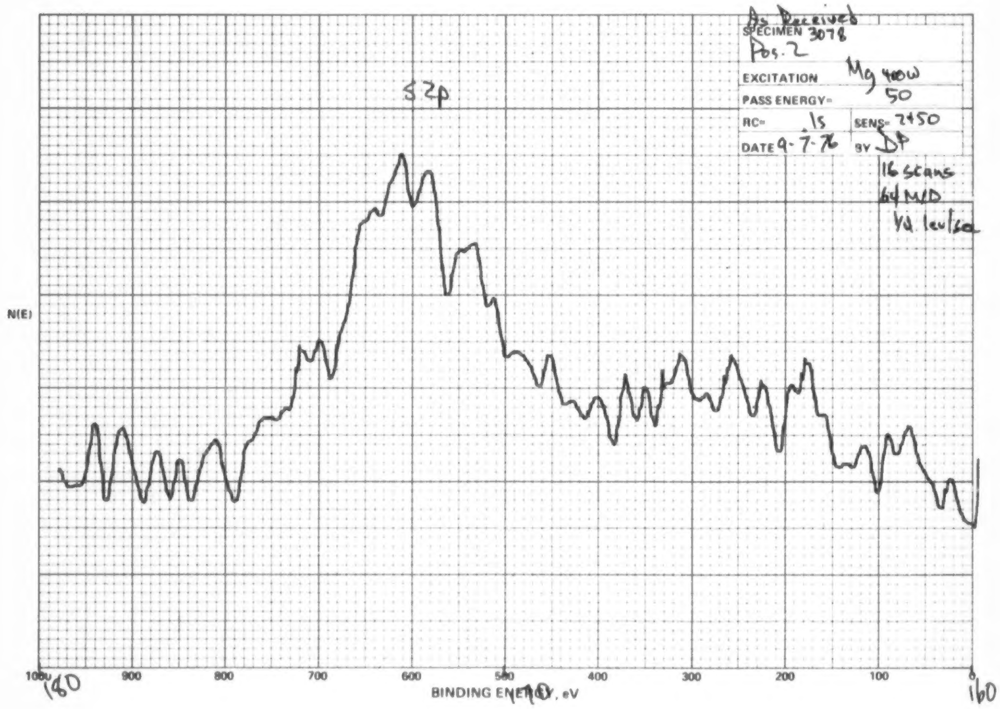


Figure F-136 - ESCA Graph - Run 31, Location 18, Stage 2, Filter 3078



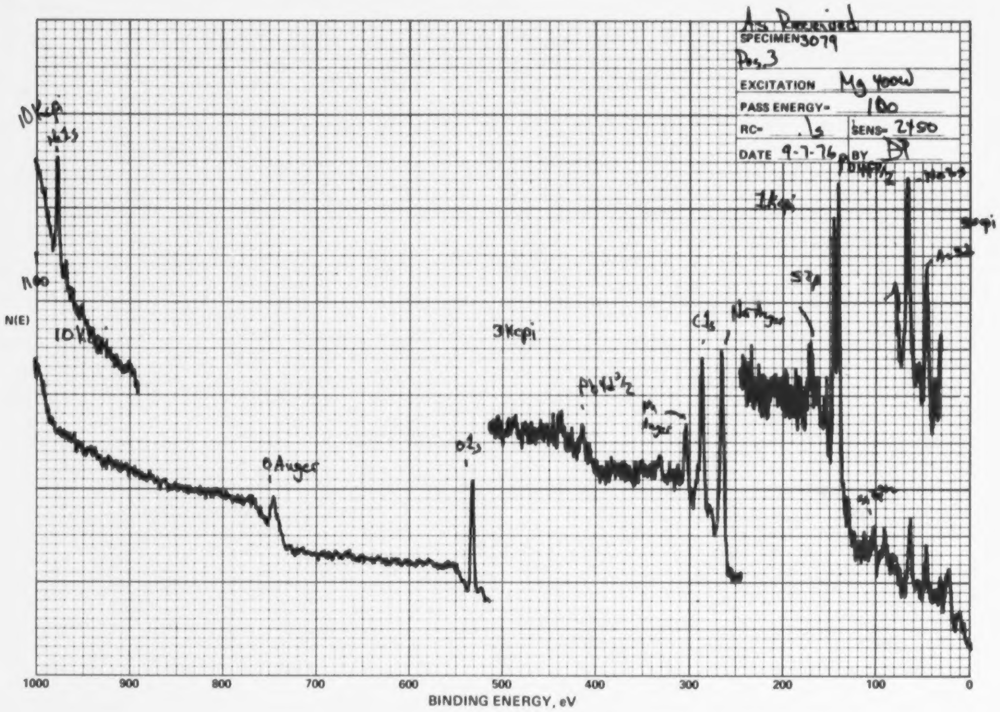
As Received
SPECIMEN 3078
Pos. 2
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .15 SENS= 2450
DATE 9-7-76 BY DP
10 scans
128 M/D
1/4 lev/sec

Figure F-137 - ESCA Graph - Run 31, Location 18, Stage 2, Filter 3078



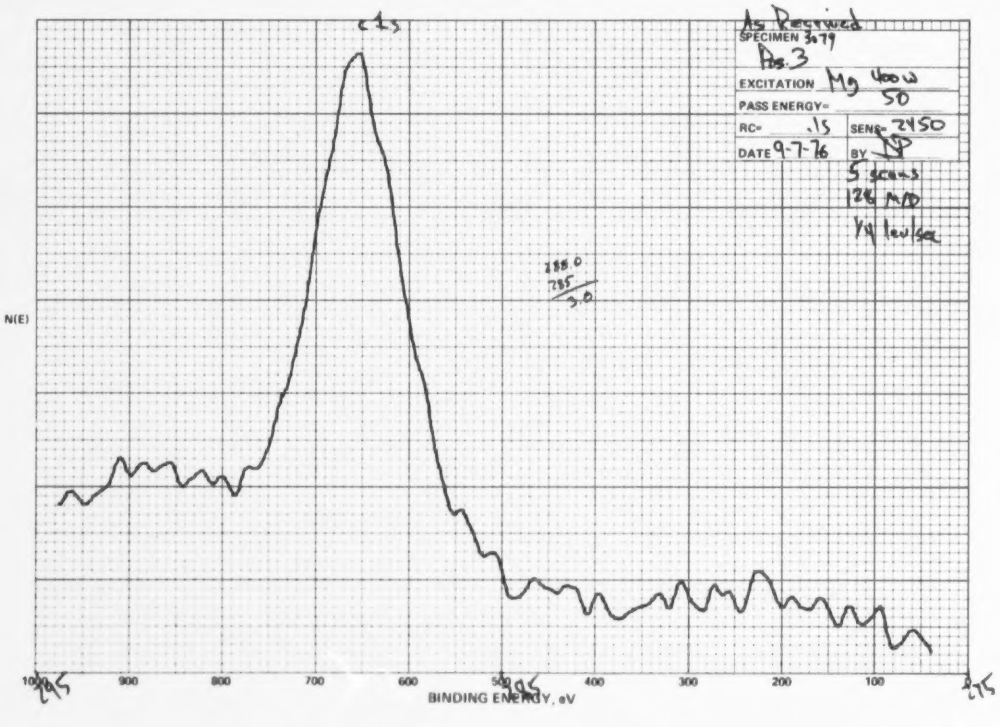
As Received
SPECIMEN 3078
Pos. 2
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .15 SENS= 2450
DATE 9-7-76 BY DP
16 scans
64 M/D
1/4 lev/sec

Figure F-138 - ESCA Graph - Run 31, Location 18, Stage 2, Filter 3078



As Received
SPECIMEN 3079
Pos. 3
EXCITATION Mg 400W
PASS ENERGY= 100
RC= .1s
SENS= 2450
DATE 9-7-76
BY DP

Figure F-139 - ESCA Graph - Run 31, Location 18, Stage 3, Filter 3079



As Received
SPECIMEN 3079
Pos. 3
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .1s
SENS= 2450
DATE 9-7-76
BY DP
5 scans
128 MD
1/4 lev/sec

Figure F-140 - ESCA Graph - Run 31, Location 18, Stage 3, Filter 3079

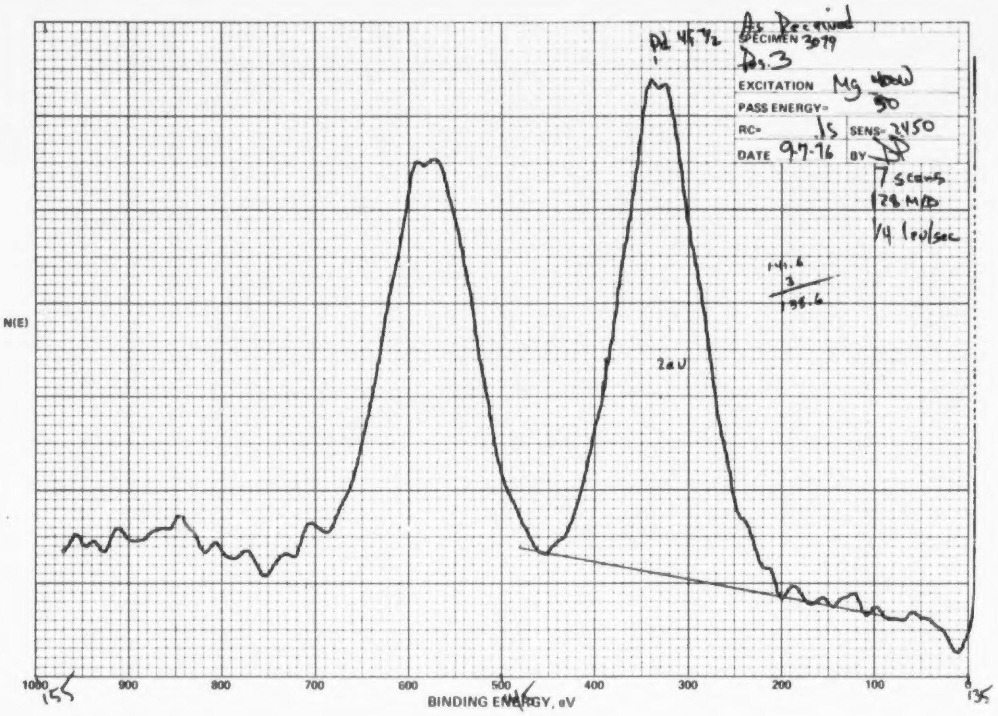


Figure F-141 - ESCA Graph - Run 31, Location 18, Stage 3, Filter 3079

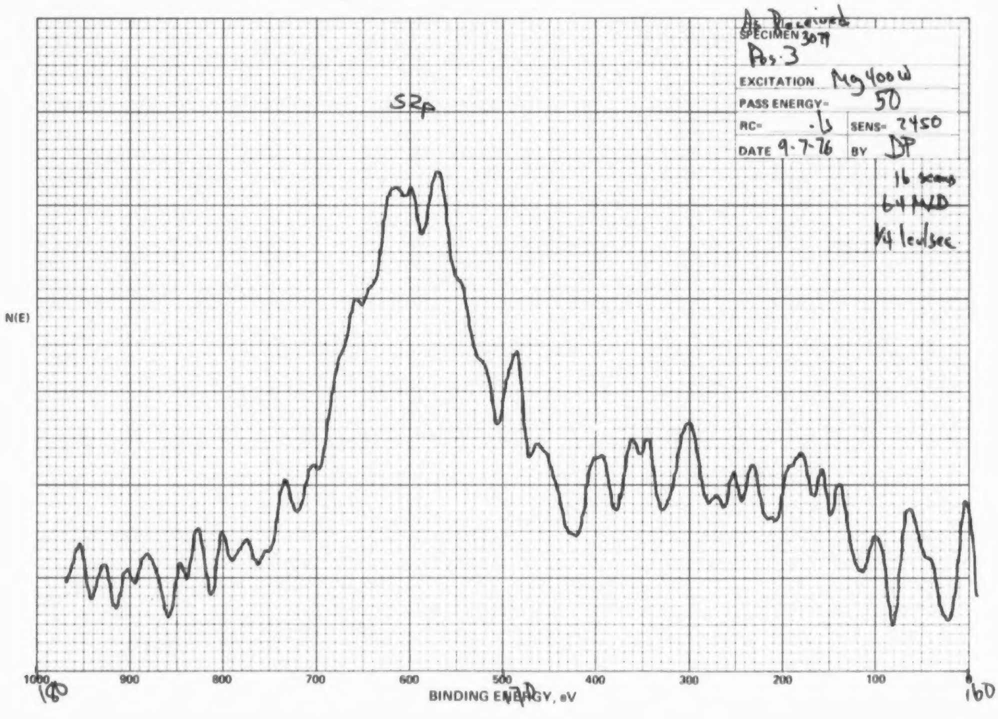


Figure F-142 - ESCA Graph - Run 31, Location 18, Stage 3, Filter 3079

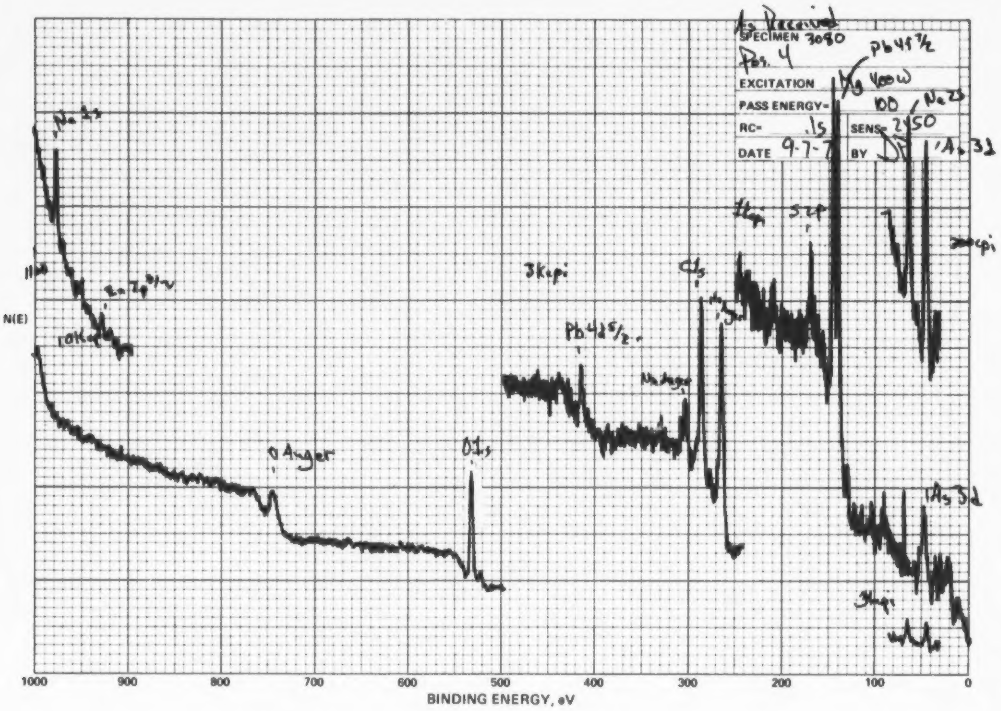


Figure F-143 - ESCA Graph - Run 31, Location 18, Stage 4, Filter 3080

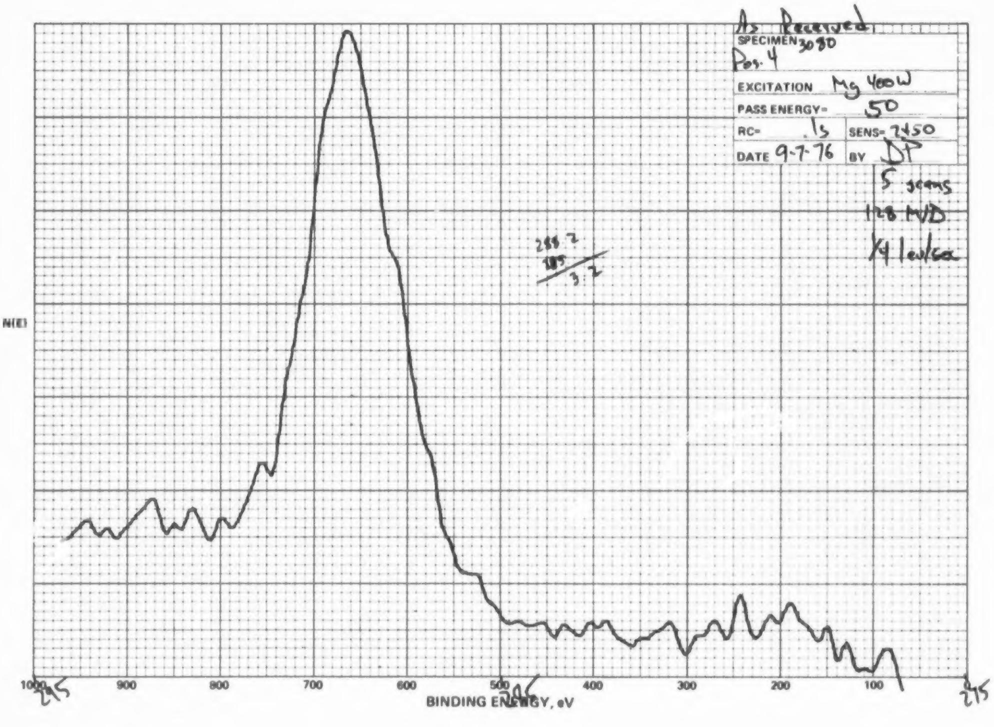
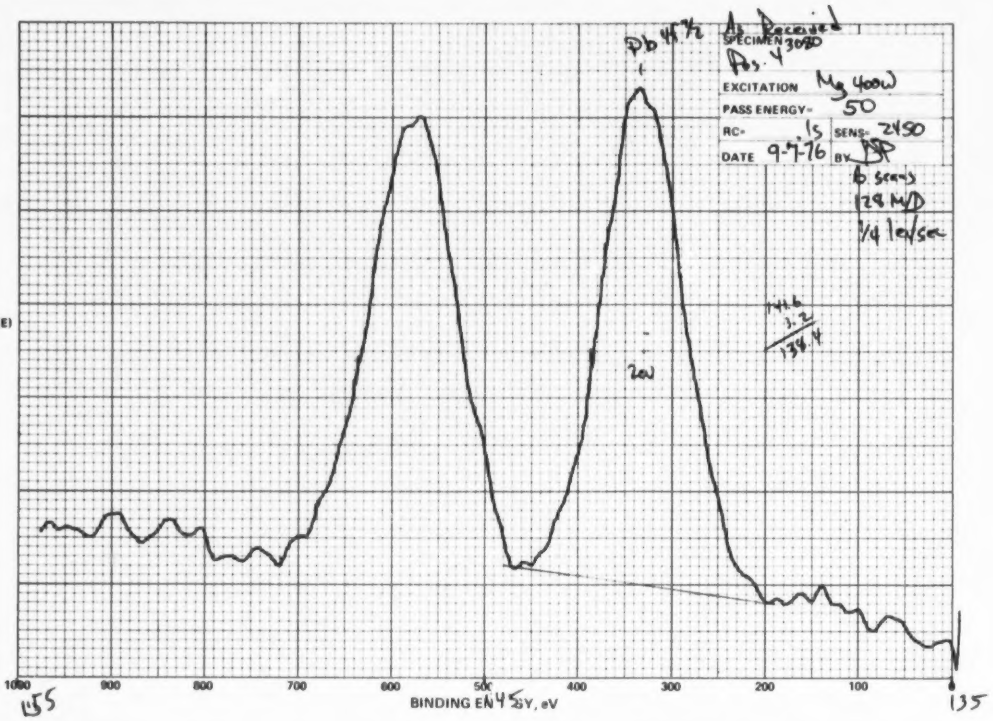
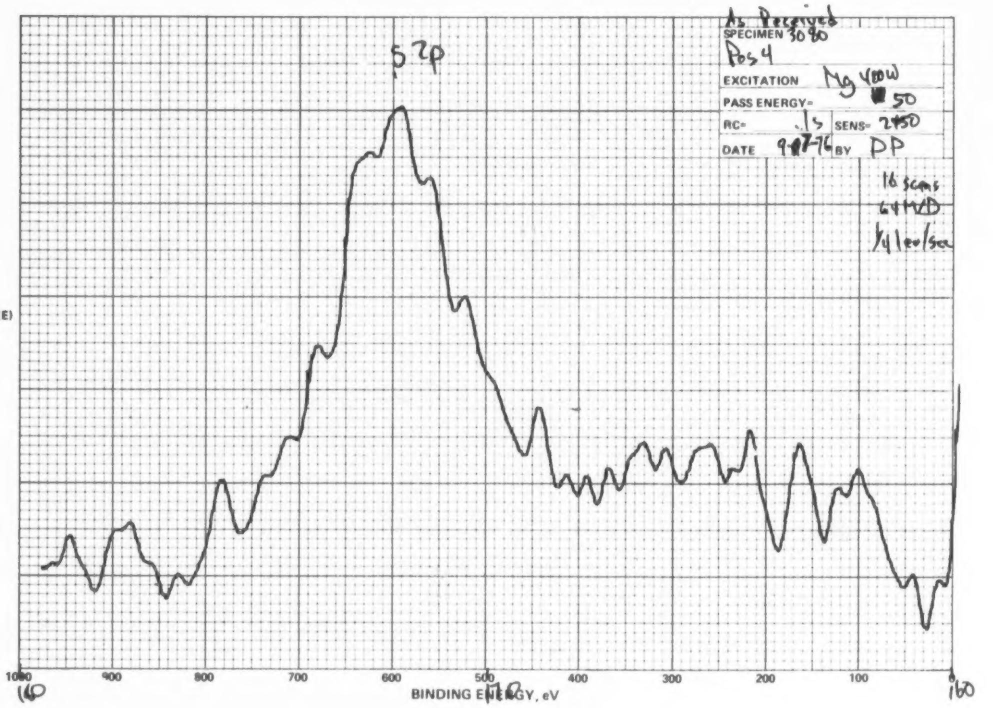


Figure F-144 - ESCA Graph - Run 31, Location 18, Stage 4, Filter 3080



As Received
SPECIMEN 3080
Pos. 4
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .1s SENS= 2450
DATE 9-7-76 BY DP
16 scans
128 M/D
1/4 1eV/sec

Figure F-145 - ESCA Graph - Run 31, Location 18, Stage 4, Filter 3080



As Received
SPECIMEN 3080
Pos 4
EXCITATION Mg 400W
PASS ENERGY= 50
RC= .1s SENS= 2450
DATE 9-7-76 BY DP
16 scans
64 M/D
1/4 1eV/sec

Figure F-146 - ESCA Graph - Run 31, Location 18, Stage 4, Filter 3080

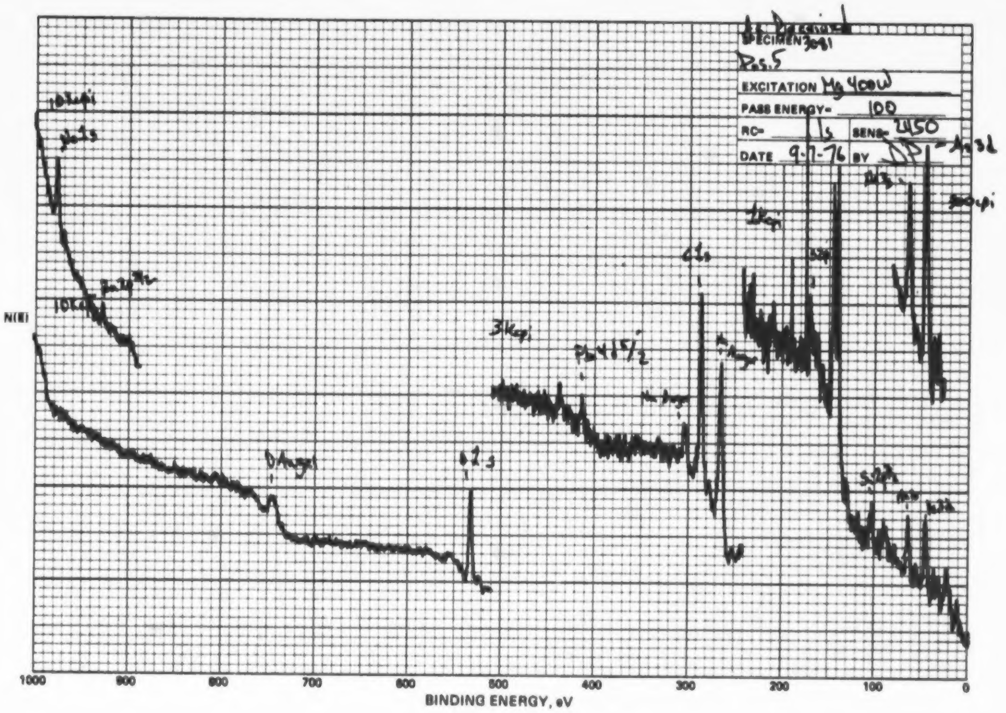


Figure F-147 - ESCA Graph - Run 31, Location 18, Stage 5, Filter 3081

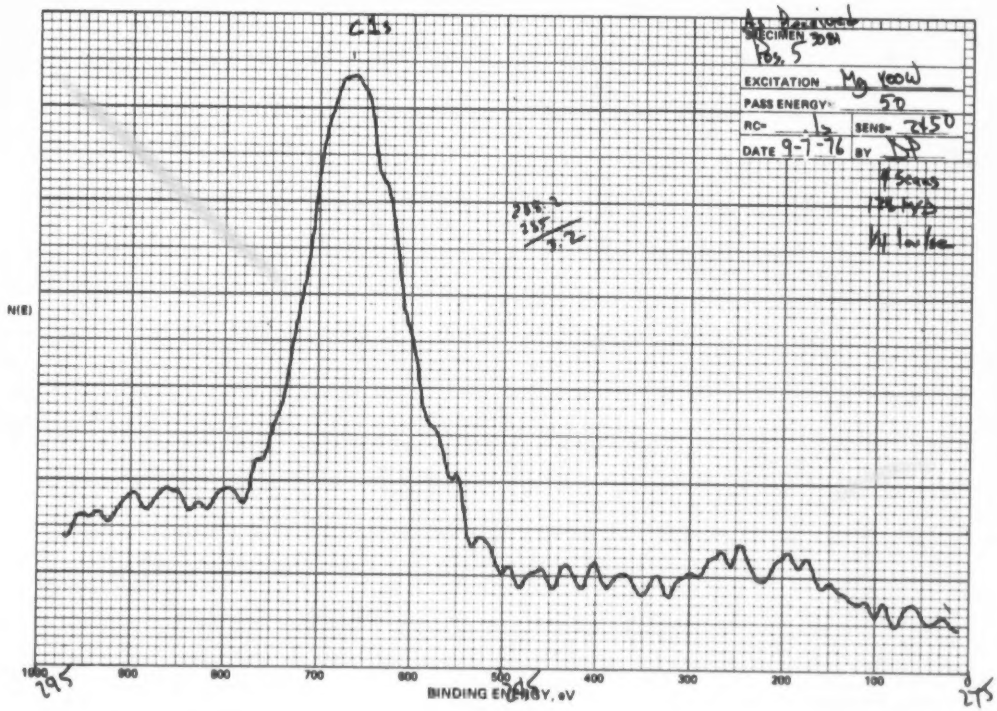


Figure F-148 - ESCA Graph - Run 31, Location 18, Stage 5, Filter 3081

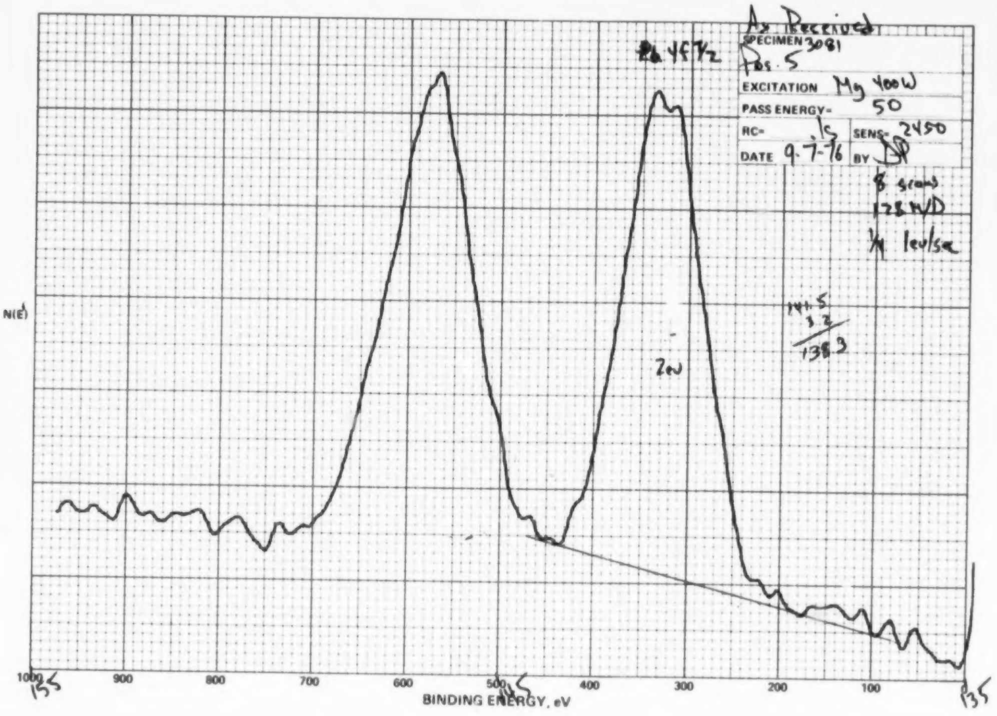


Figure F-149 - ESCA Graph - Run 31, Location 18, Stage 5, Filter 3081

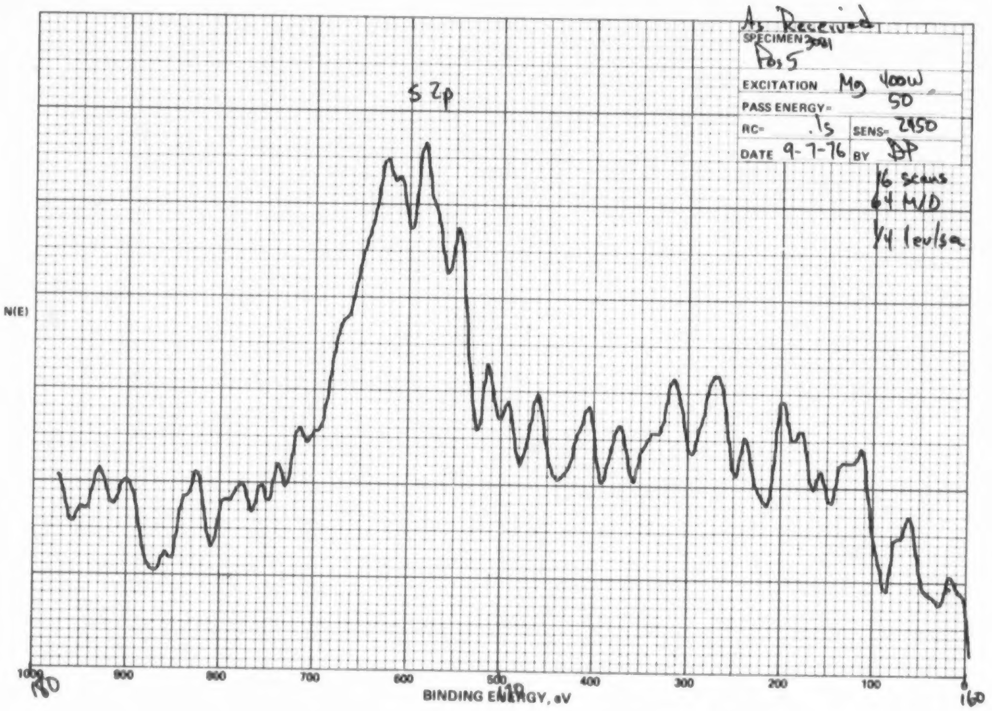


Figure F-150 - ESCA Graph - Run 31, Location 18, Stage 5, Filter 3081

APPENDIX G

X-RAY DIFFRACTION CHARTS ON SPECIES DETERMINATION

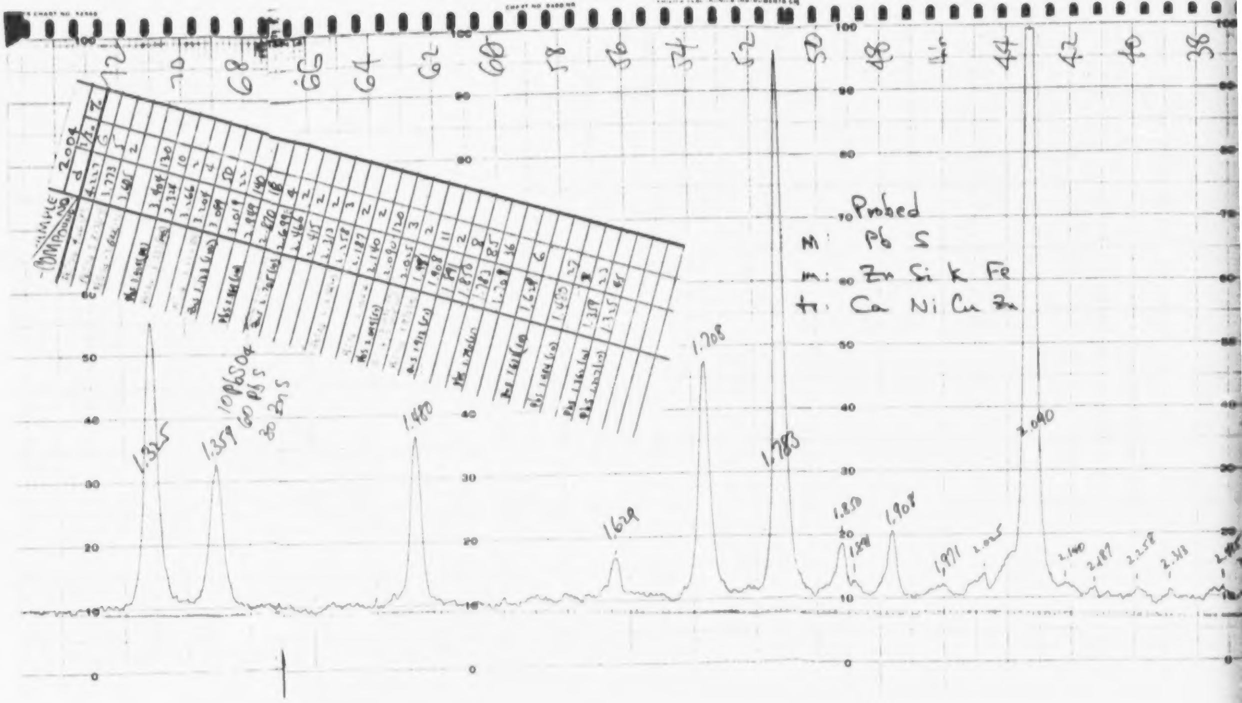


Figure G-1 - Run 1, Location 1B, Filter 2004

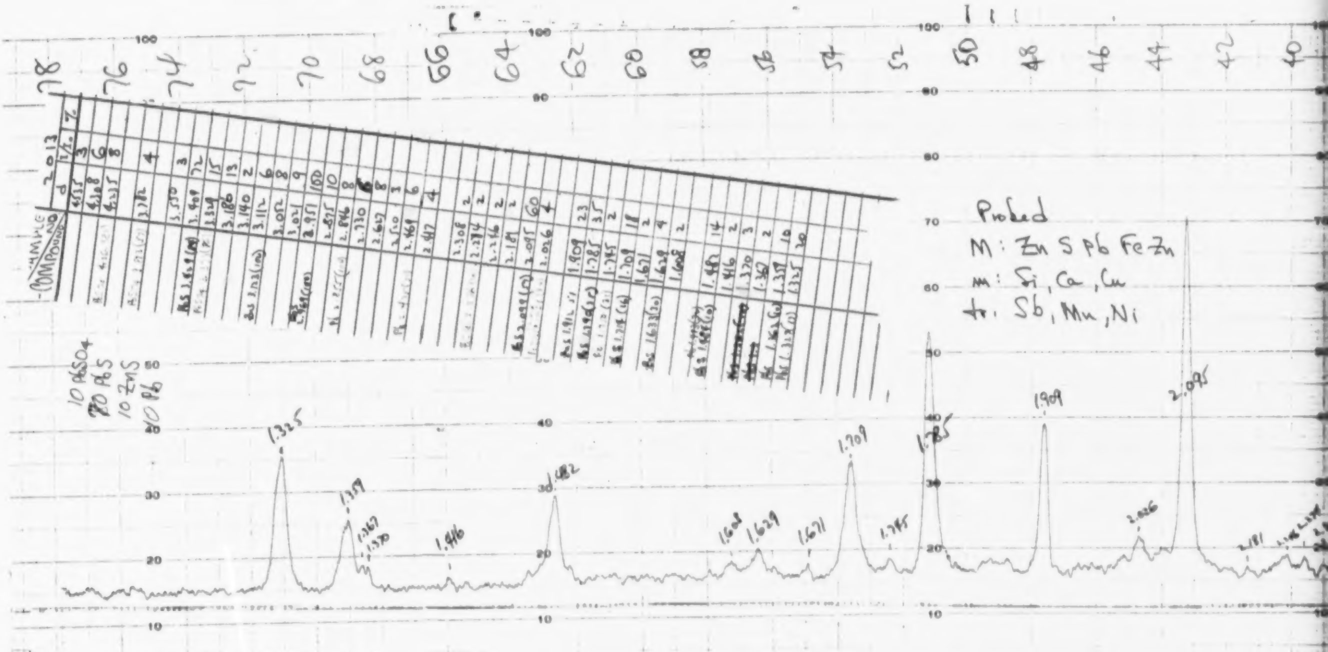


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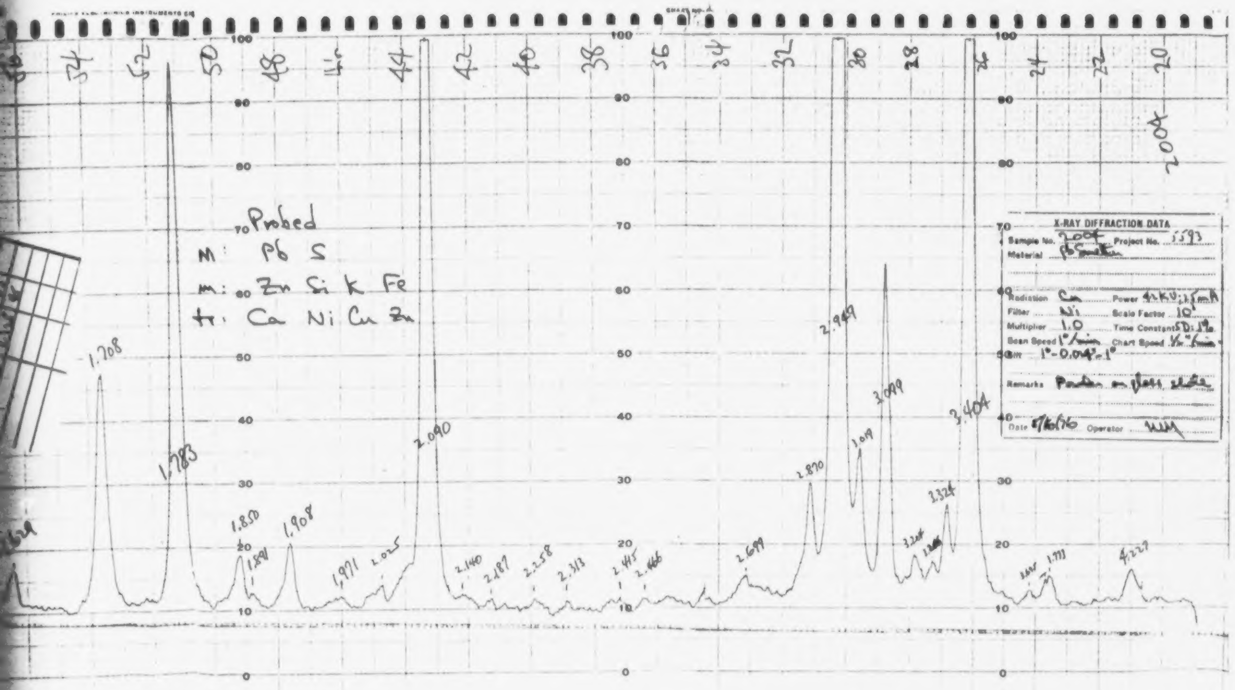
Figure G-2 - Run 2, Location 3, Filter 2013



X-RAY DIFFRACTION DATA

Sample No. 2004 Project No. 5593
Material Pb [illegible]
Radiation Cu Power 42KV; 15mA
Filter Ni Scale Factor 10
Multiplier 1.0 Time Constant SD: 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.04°-1°
Remarks Powder on glass slide
Date 5/10/76 Operator WM

Figure G-1 - Run 1, Location 1B, Filter 2004

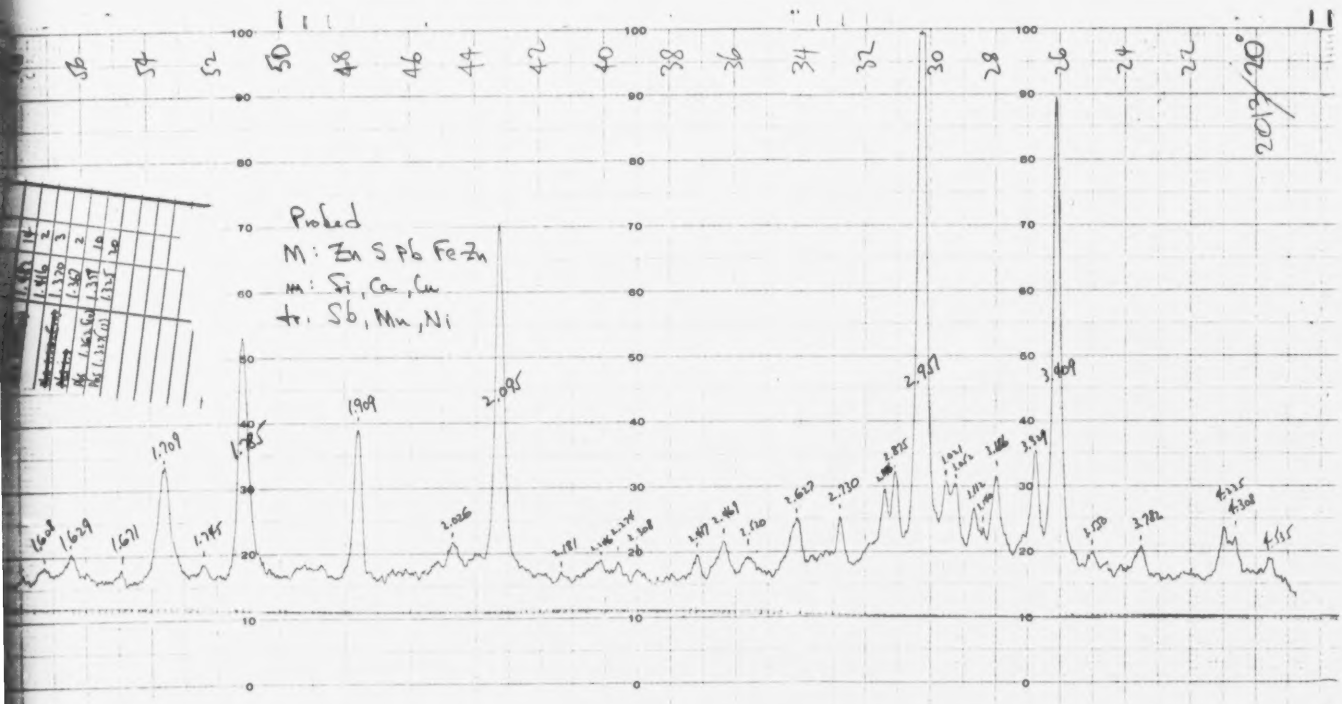
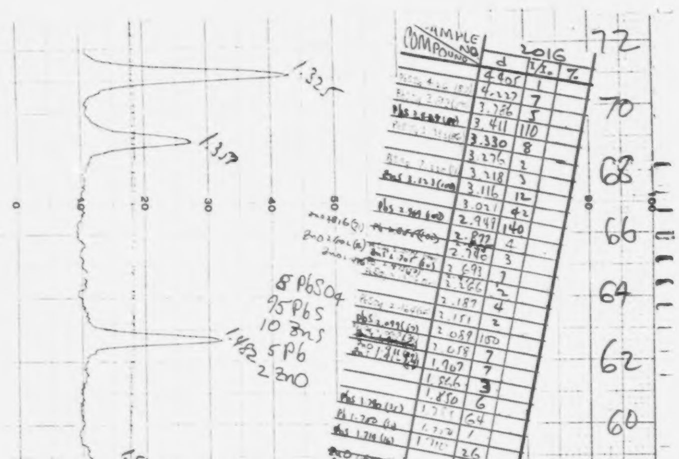


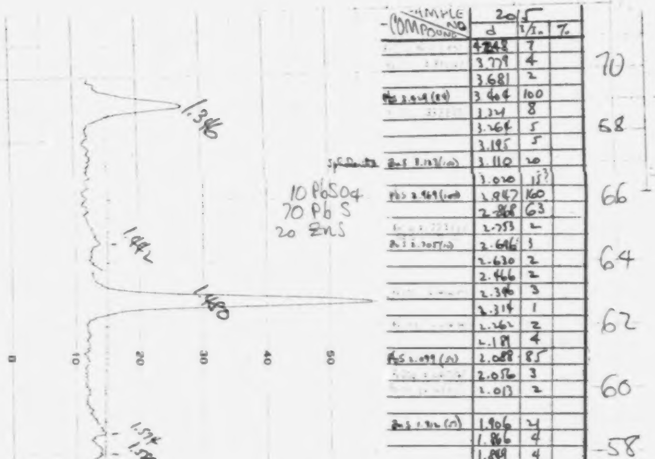
Figure G-2 - Run 2, Location 3, Filter 2013



8 PbSO4
95 PbS
10 ZnS
5 Pb
2 ZnO

ZnO 2.816(71)
ZnO 2.602(56)

COMPOUND \ SAMPLE NO	2016 d	I/I₀	%
[illegible]	4.405	1	
[illegible]	4.227	7	
[illegible]	3.726	5	
PbS 3.429(84)	3.411	110	
[illegible]	3.330	8	
	3.276	2	
[illegible]	3.218	3	
ZnS 3.123(100)	3.116	12	
	3.021	42	
PbS 2.969(100)	2.949	140	
~~[illegible]~~	2.877	4	
ZnS 2.705(10)	2.780	3	
[illegible]	2.693	7	
[illegible]	2.266	2	
[illegible]	2.187	4	
[illegible]	2.151	2	
PbS 2.099(57)	2.089	150	
~~[illegible]~~	2.058	7	
ZnS 1.911(92)	1.967	7	
	1.866	3	
	1.850	6	
PbS 1.790(35)	1.777	64	
Pb 1.750 (..)	1.726	1	
PbS 1.714 (16)	1.710	26	



10 PbSO4
70 PbS
20 ZnS

COMPOUND \ SAMPLE NO	2015 d	I/I₀	%
[illegible]	4.248	7	
[illegible]	3.779	4	
	3.681	2	
PbS 3.429(84)	3.464	100	
[illegible]	3.324	8	
	3.264	5	
	3.195	5	
sphalerite ZnS 3.123(100)	3.110	20	
	3.020	15?	
PbS 2.969(100)	2.947	160	
	2.868	63	
[illegible]	2.753	2	
ZnS 2.705(10)	2.696	3	
	2.630	2	
	2.466	2	
[illegible]	2.396	3	
	2.314	1	
[illegible]	2.262	2	
	2.189	4	
PbS 2.099 (57)	2.088	85	
[illegible]	2.056	3	
[illegible]	2.013	2	
ZnS 1.912 (51)	1.906	4	
	1.866	4	
	1.849	4	

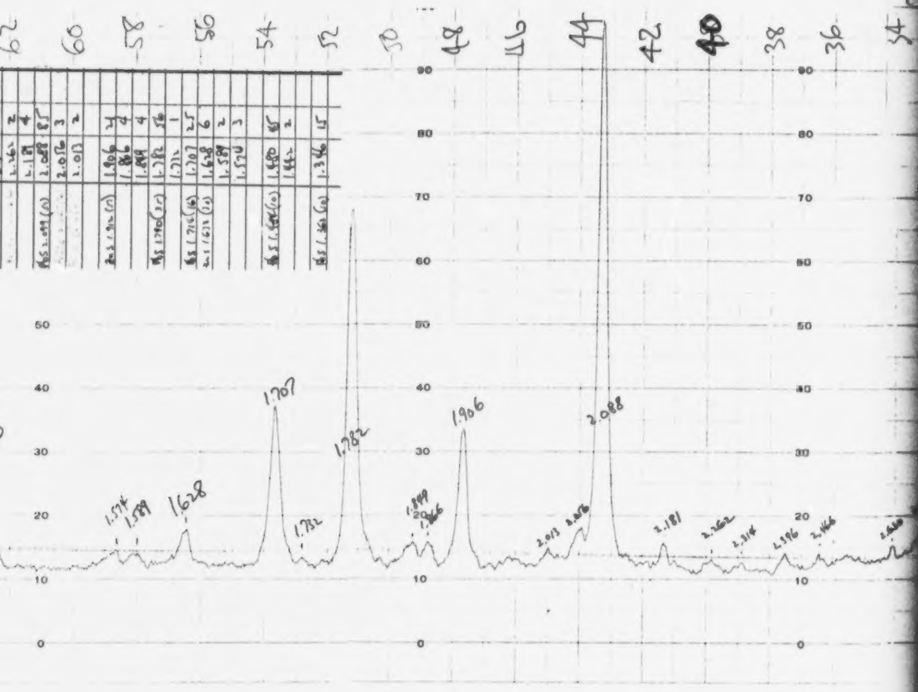


Figure G-3 - Run 2, Location 1, BU, Filter 2015

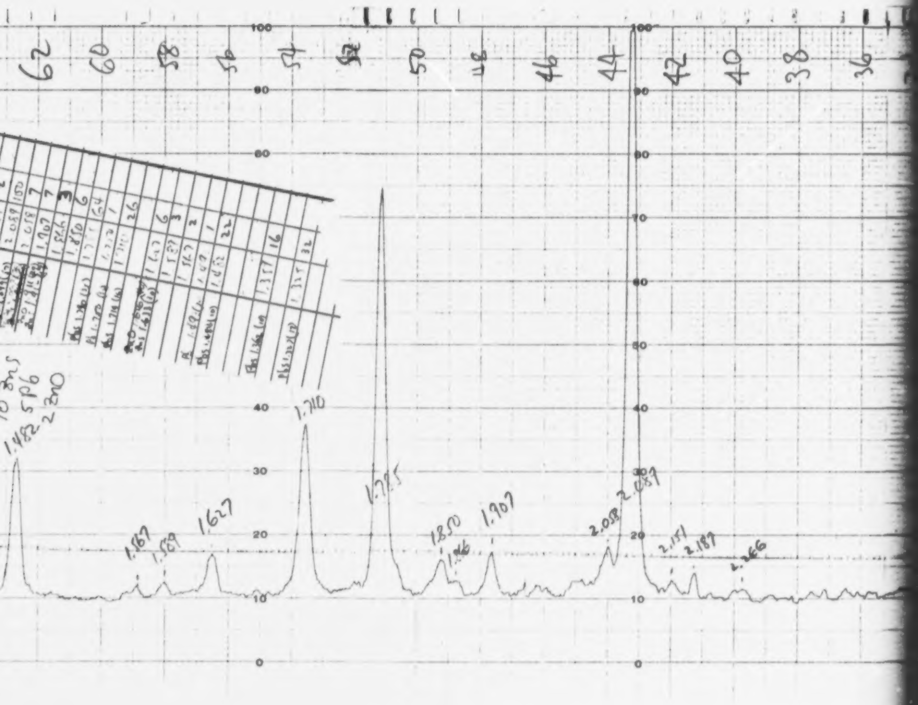
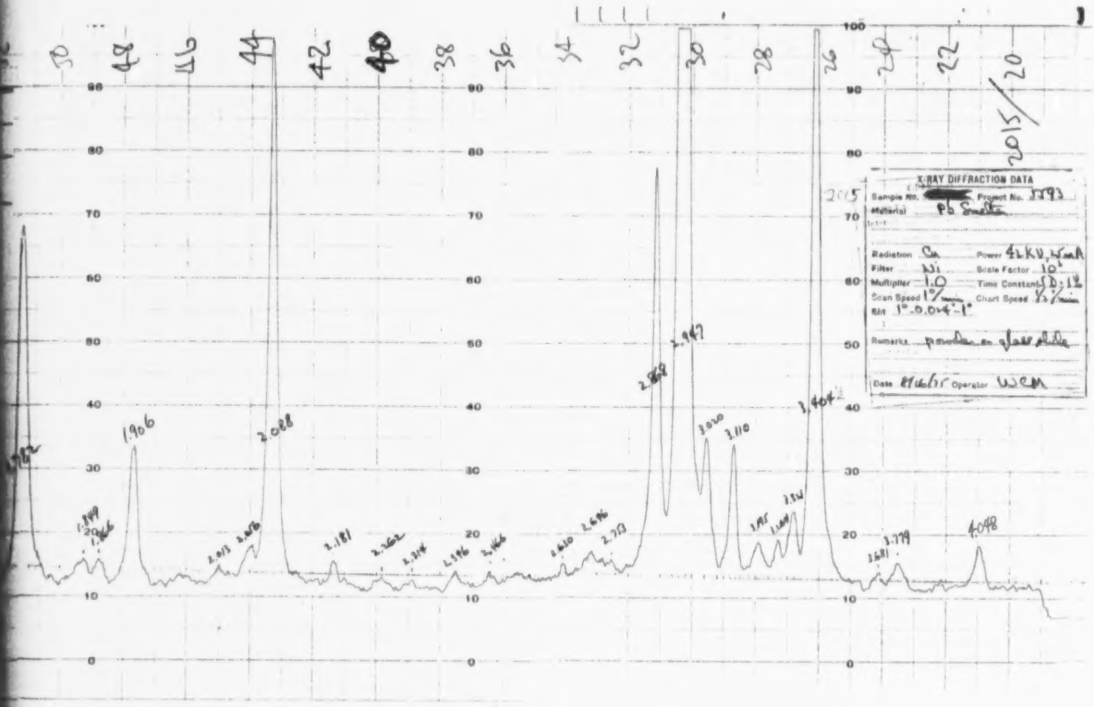


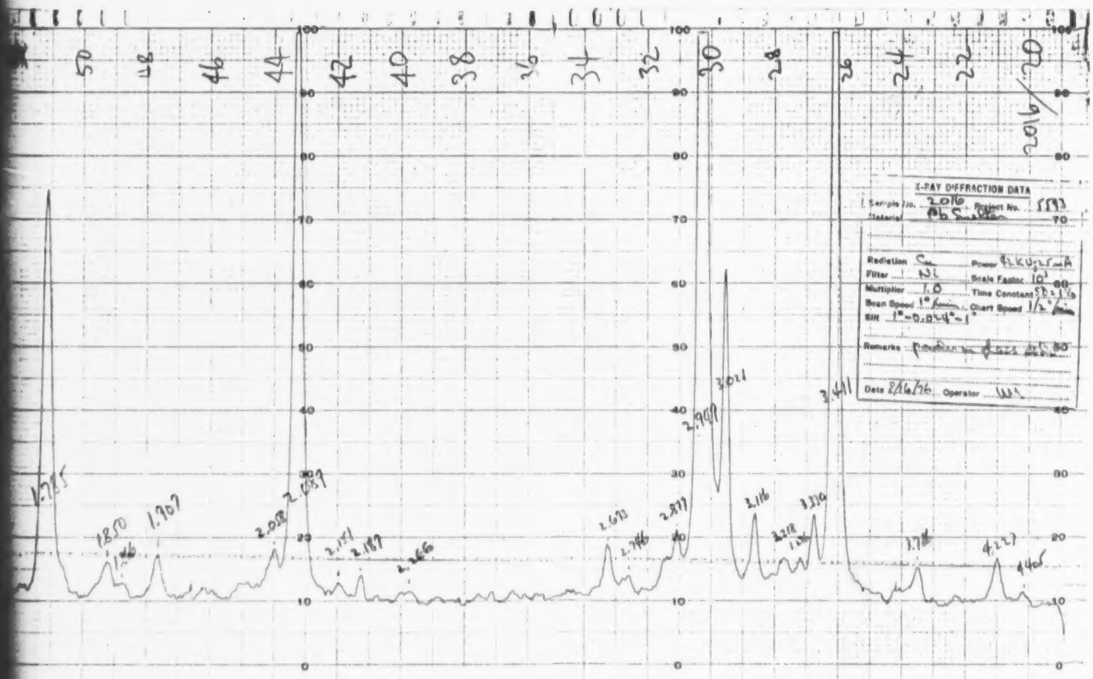
Figure G-4 - Run 3,Location 2S, Filter 2016



X-RAY DIFFRACTION DATA

Sample No. [redacted] Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV, 15mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD: 1½
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.04°-1°
Remarks powder on glass slide
Date 8/16/75 Operator WCM

-3 - Run 2, Location 1, BU, Filter 2015



X-RAY DIFFRACTION DATA

Sample No. 2016 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV, 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD: 1½
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.04°-1
Remarks powder on glass slide
Date 8/16/76 Operator W

G-4 - Run 3,Location 2S, Filter 2016

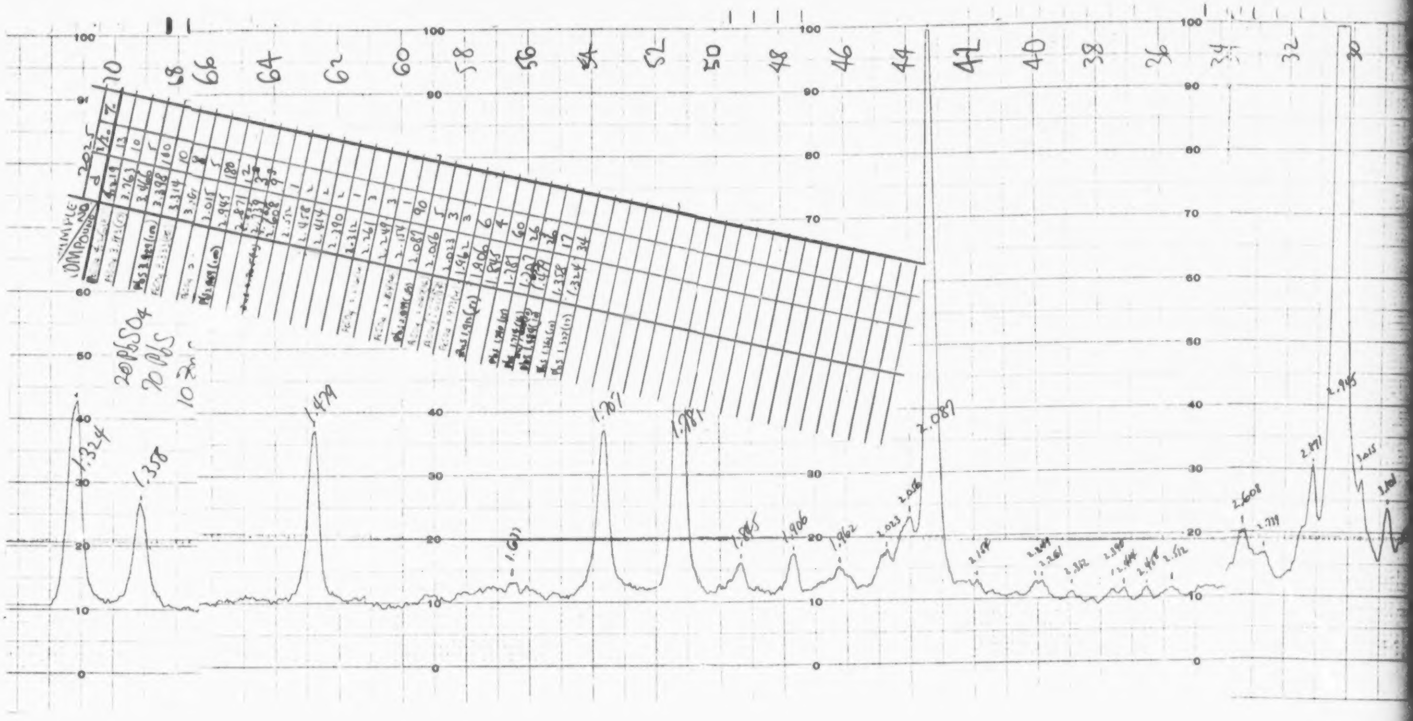


Figure G-5 - Run 4, Location 2N, Filter 2025

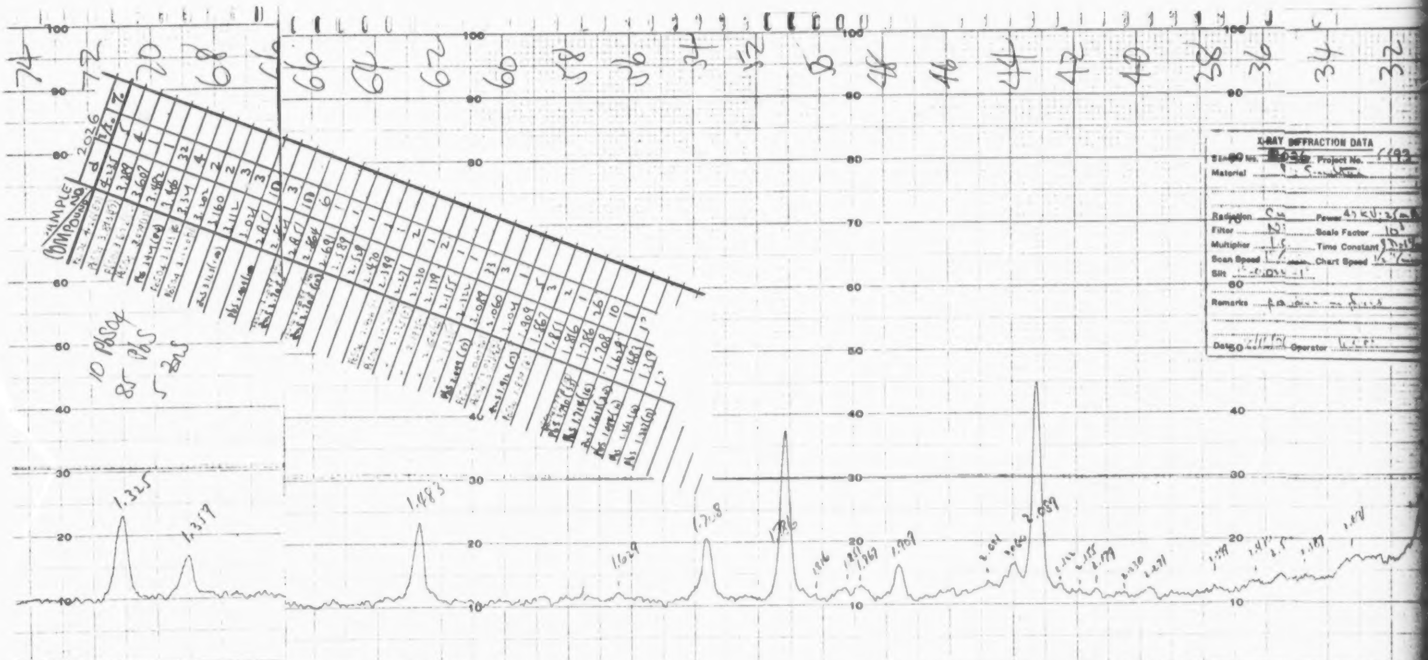
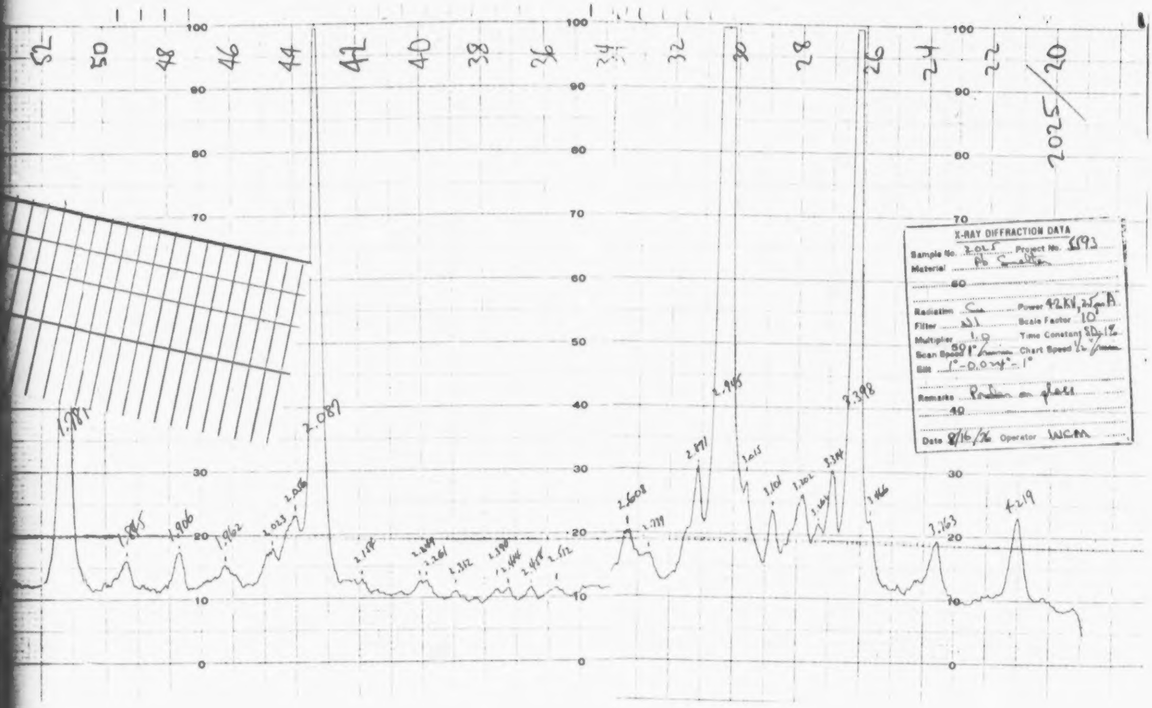


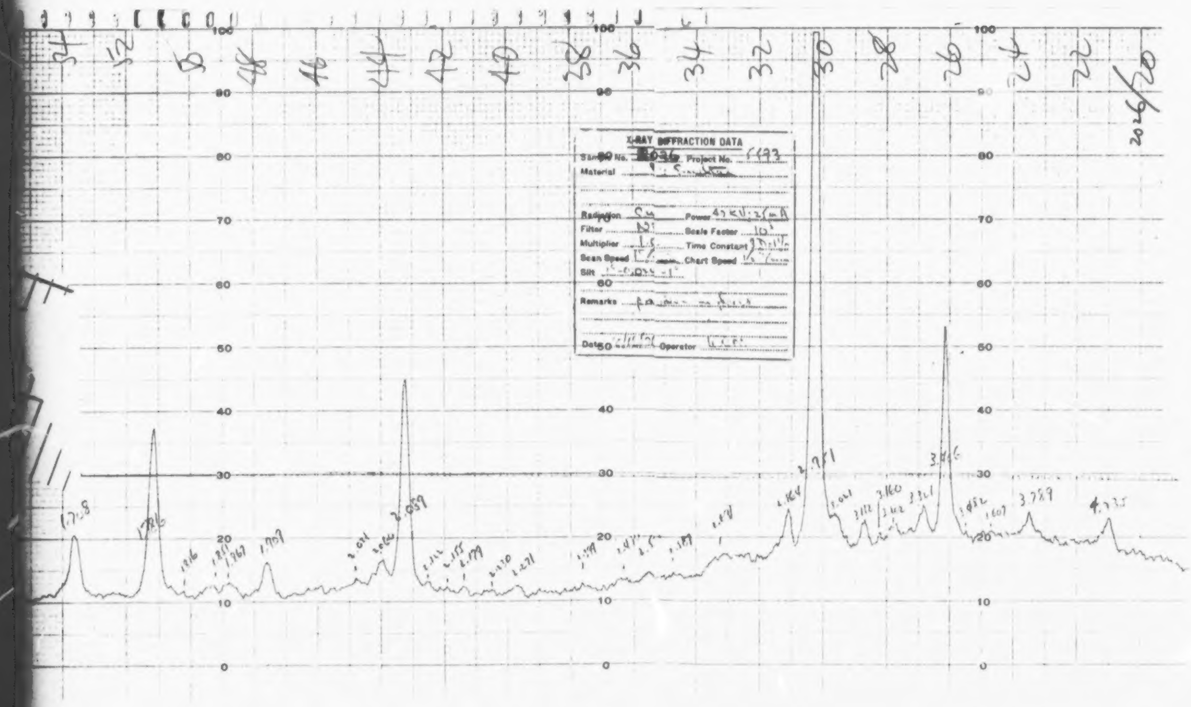
Figure G-6 - Run 4, Location 3, Backup, Filter 2026



X-RAY DIFFRACTION DATA

Sample No. 2025 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV, 25mA
Filter Ni Scale Factor 10'
Multiplier 1.0 Time Constant SD-1
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.024°-1°
Remarks Powder on glass
Date 8/16/76 Operator WCM

ure G-5 - Run 4, Location 2N, Filter 2025



X-RAY DIFFRACTION DATA

Sample No. [illegible]026 Project No. 5593
Material [illegible]
Radiation Cu Power 42 KV; 25 mA
Filter Ni Scale Factor 10'
Multiplier 1.5 Time Constant [illegible]
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.025-1°
Remarks [illegible]
Date [illegible] Operator [illegible]

-6 - Run 4, Location 3, Backup, Filter 2026

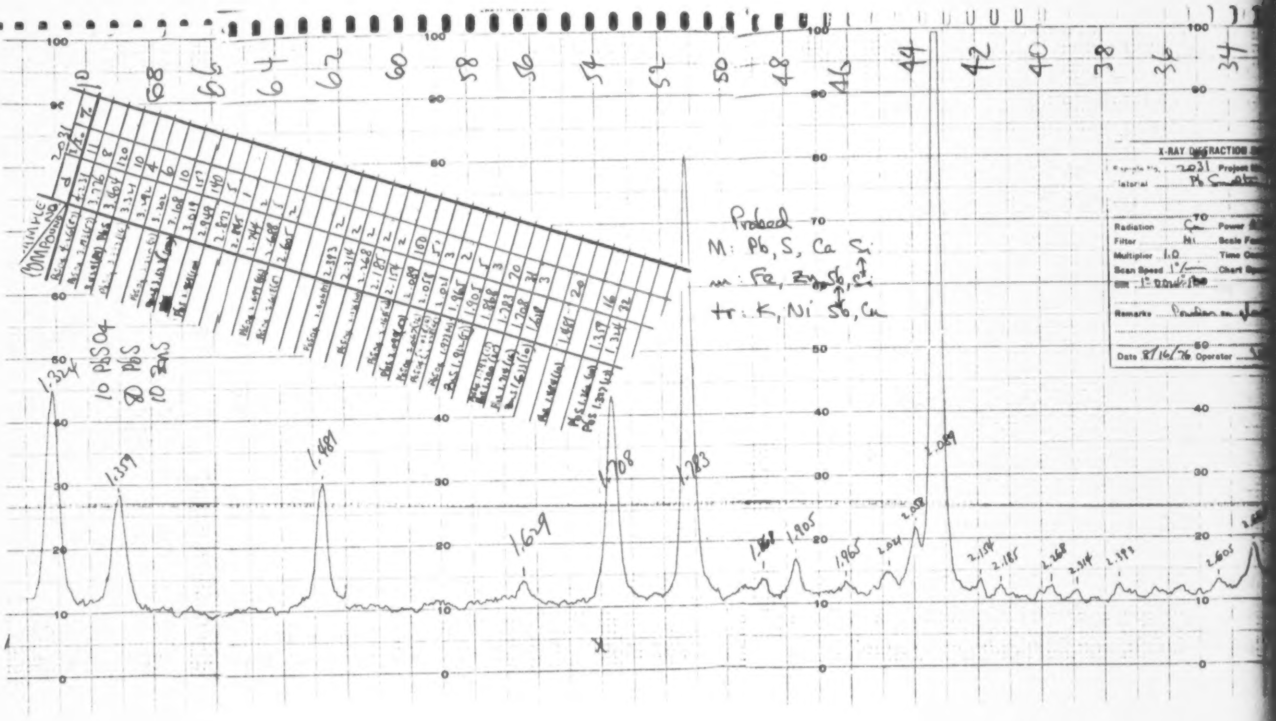


Figure G-7 - Run 5, Location 1T, Filter 2031

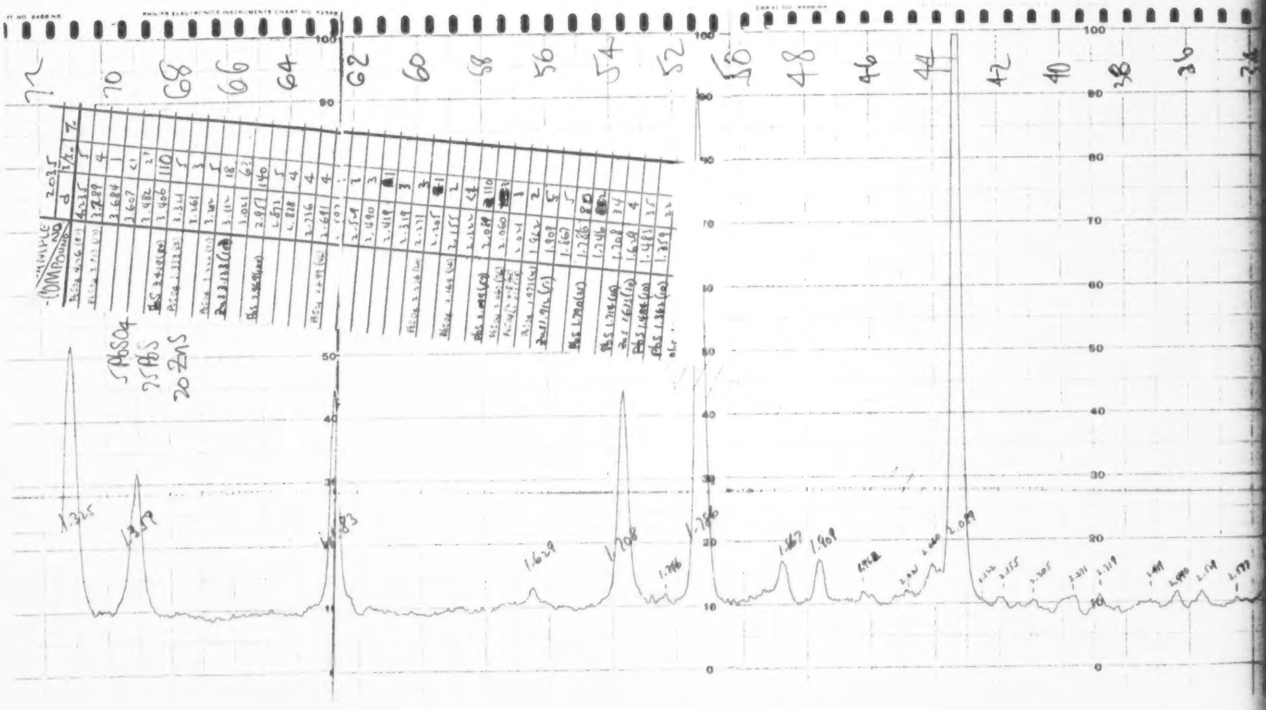
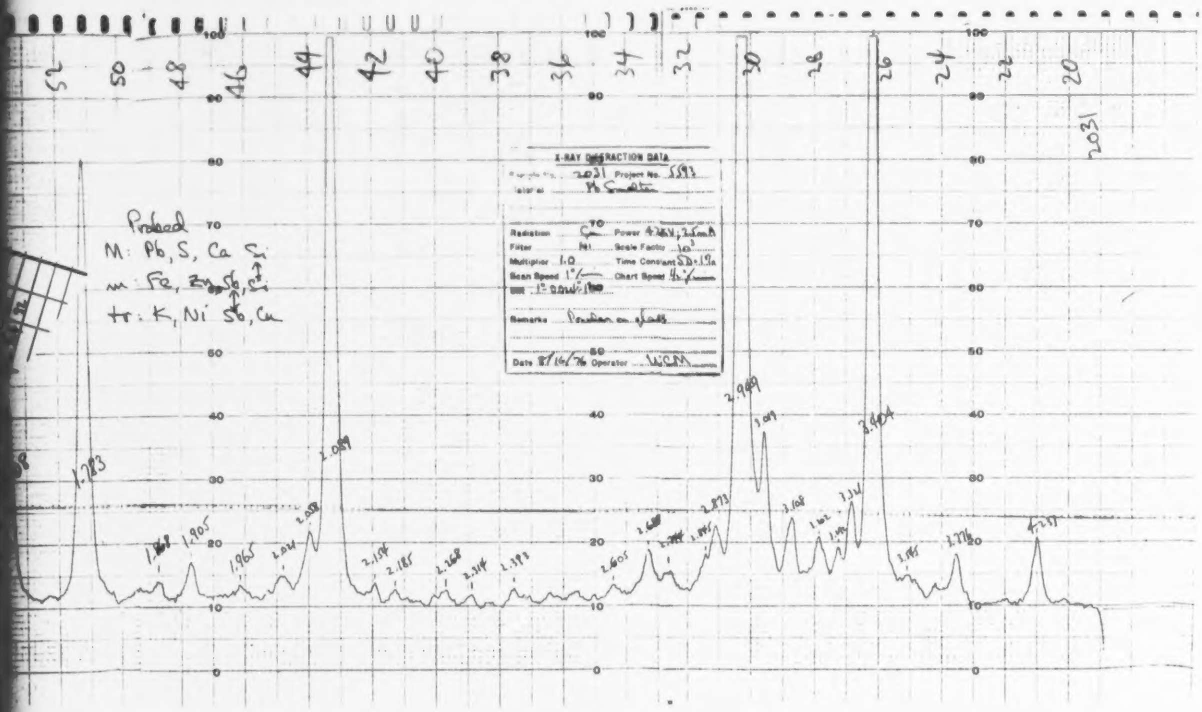


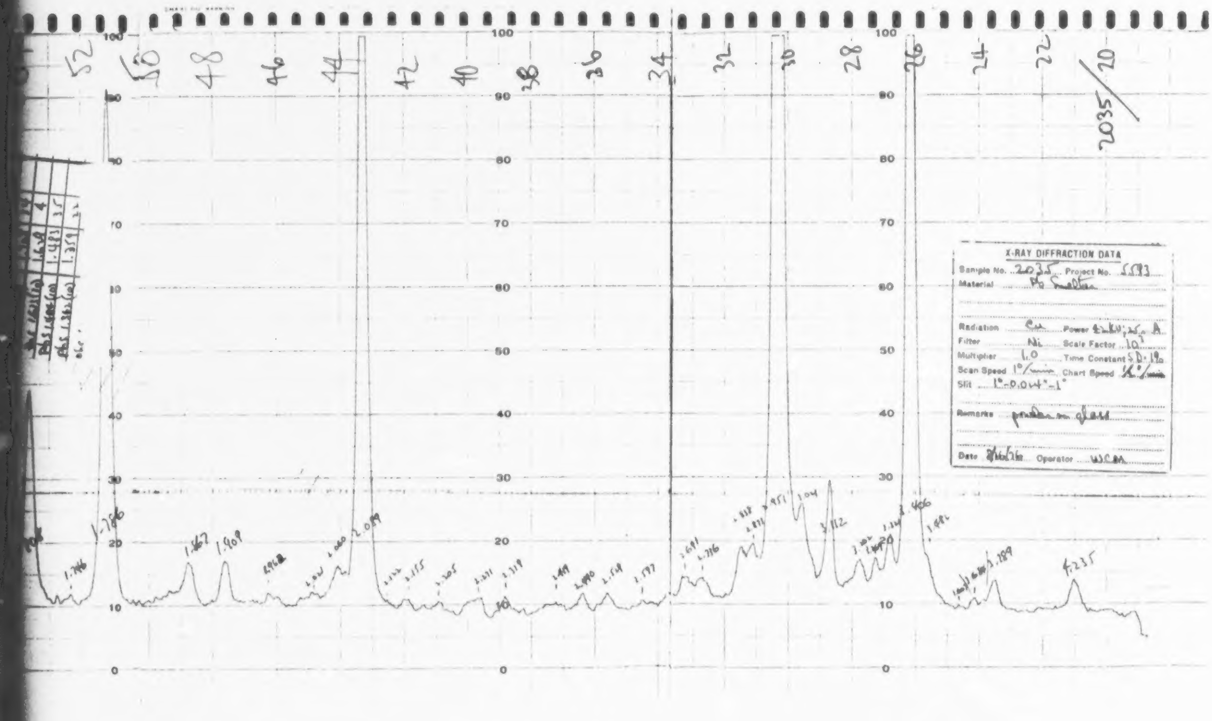
Figure G-8 - Run 6, Location 4, Filter 2035



X-RAY DIFFRACTION DATA

Sample No. 2031 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42kV; 25mA
Filter Ni Scale Factor 10^3
Multiplier 1.0 Time Constant SD·19a
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.006"-1°
Remarks Powder on glass
Date 8/16/76 Operator WCM

igure G-7 - Run 5, Location 1T, Filter 2031



X-RAY DIFFRACTION DATA

Sample No. 2035 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42kV; 25mA
Filter Ni Scale Factor 10^3
Multiplier 1.0 Time Constant SD·19a
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.004"-1°
Remarks powder on glass
Date 8/16/76 Operator WCM

igure G-8 - Run 6, Location 4, Filter 2035

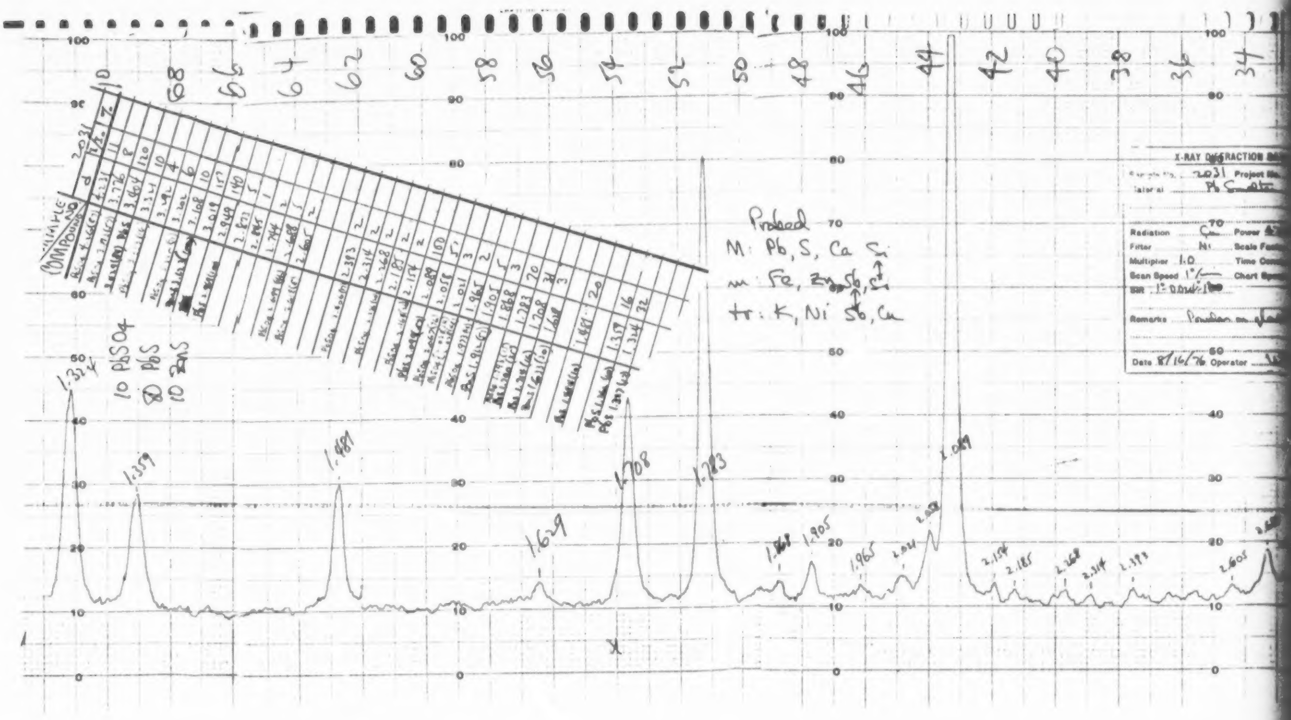


Figure G-7 - Run 5, Location 1T, Filter 2031

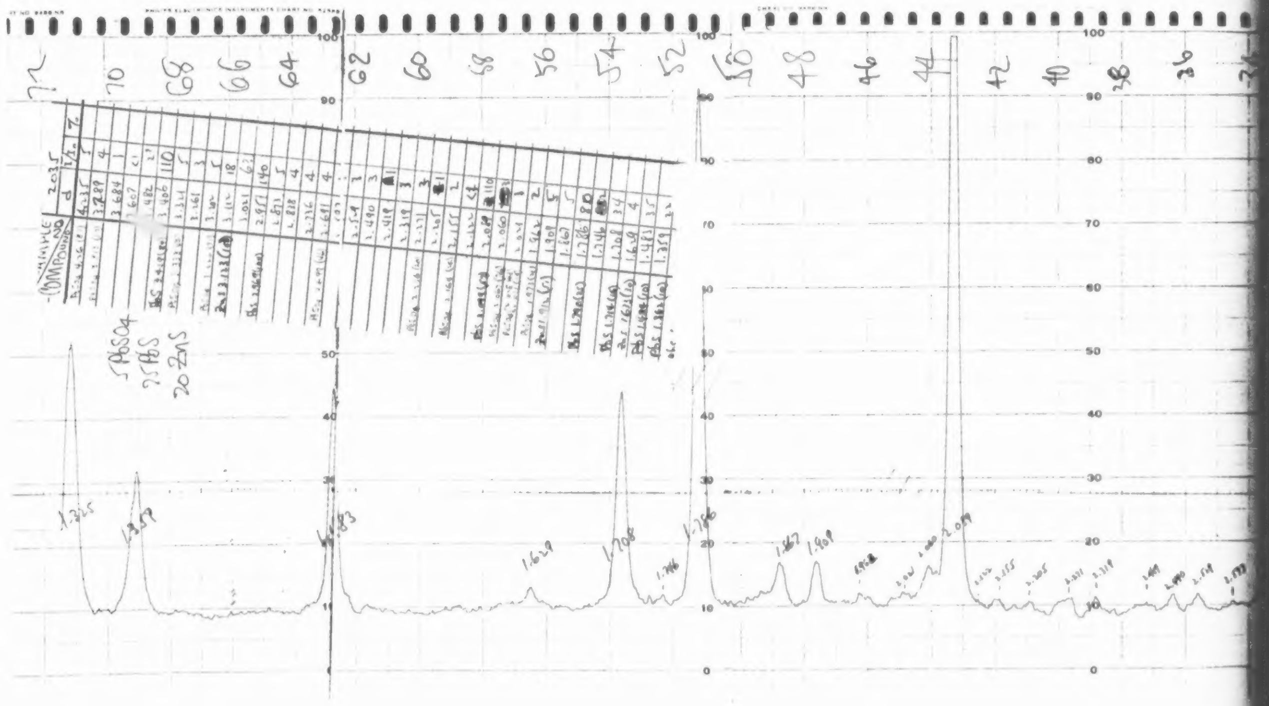
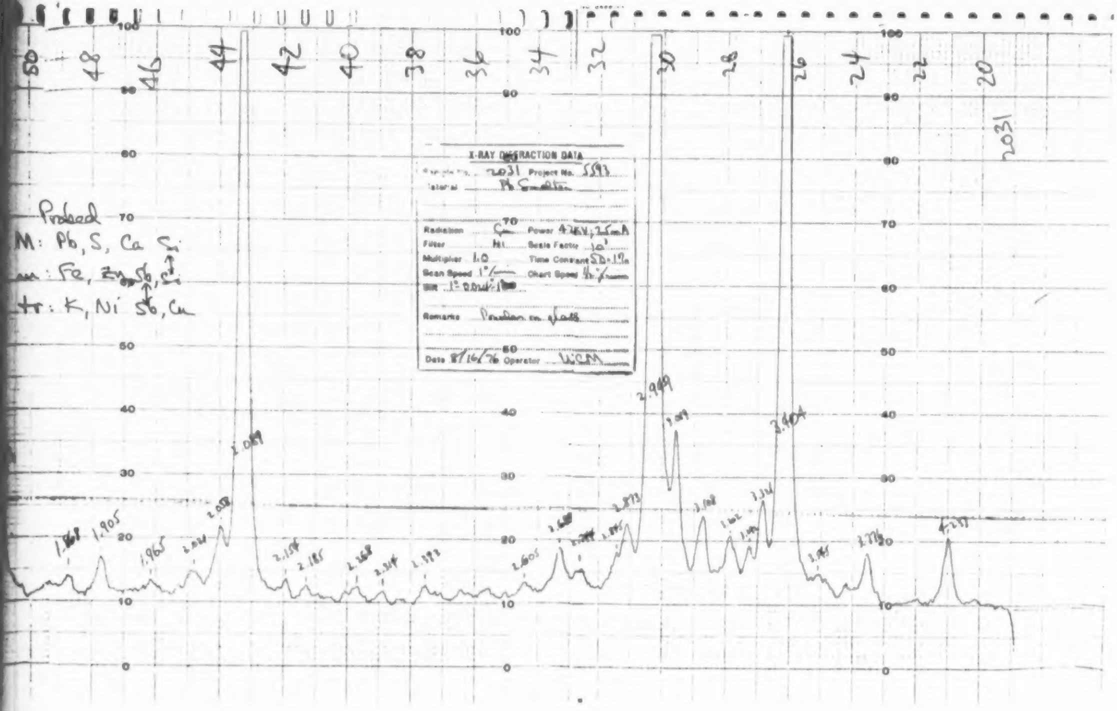


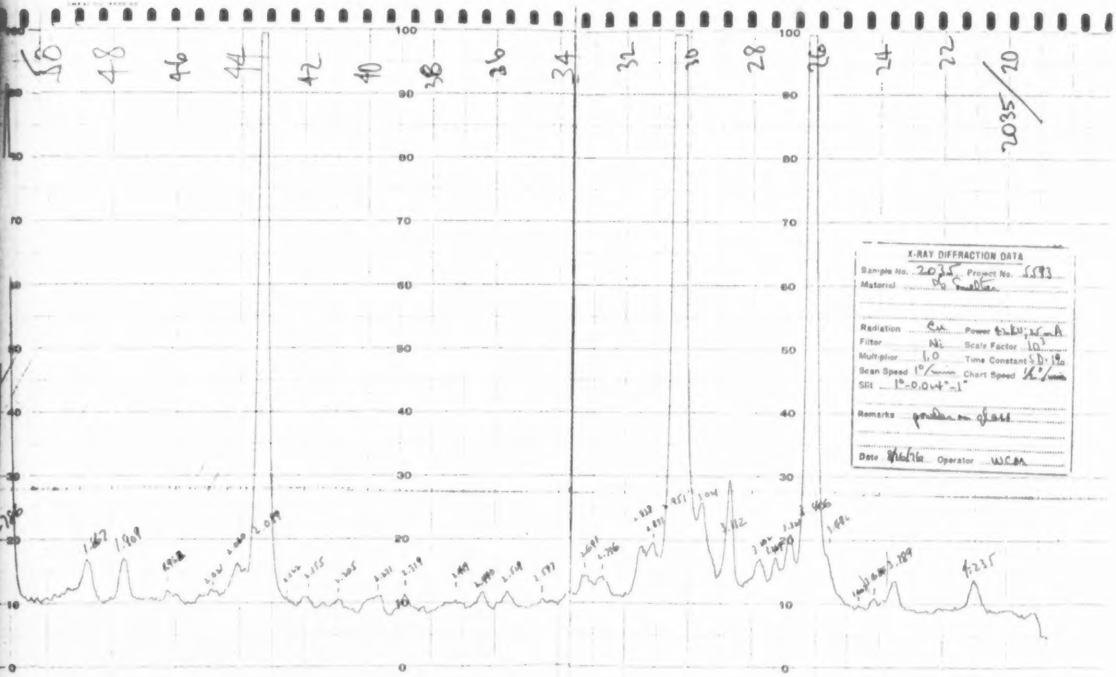
Figure G-8 - Run 6, Location 4, Filter 2035



Probed
M: Pb, S, Ca Si
m: Fe, Zn, Sb, Si
tr: K, Ni Sb, Cu

X-RAY DIFFRACTION DATA
Sample No. 2031 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD·1
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.004"-1°
Remarks Powder on glass
Date 8/16/76 Operator WCM

G-7 - Run 5, Location 1T, Filter 2031



X-RAY DIFFRACTION DATA
Sample No. 2035 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD·1
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.004"-1°
Remarks powder on glass
Date 8/16/76 Operator WCM

G-8 - Run 6, Location 4, Filter 2035

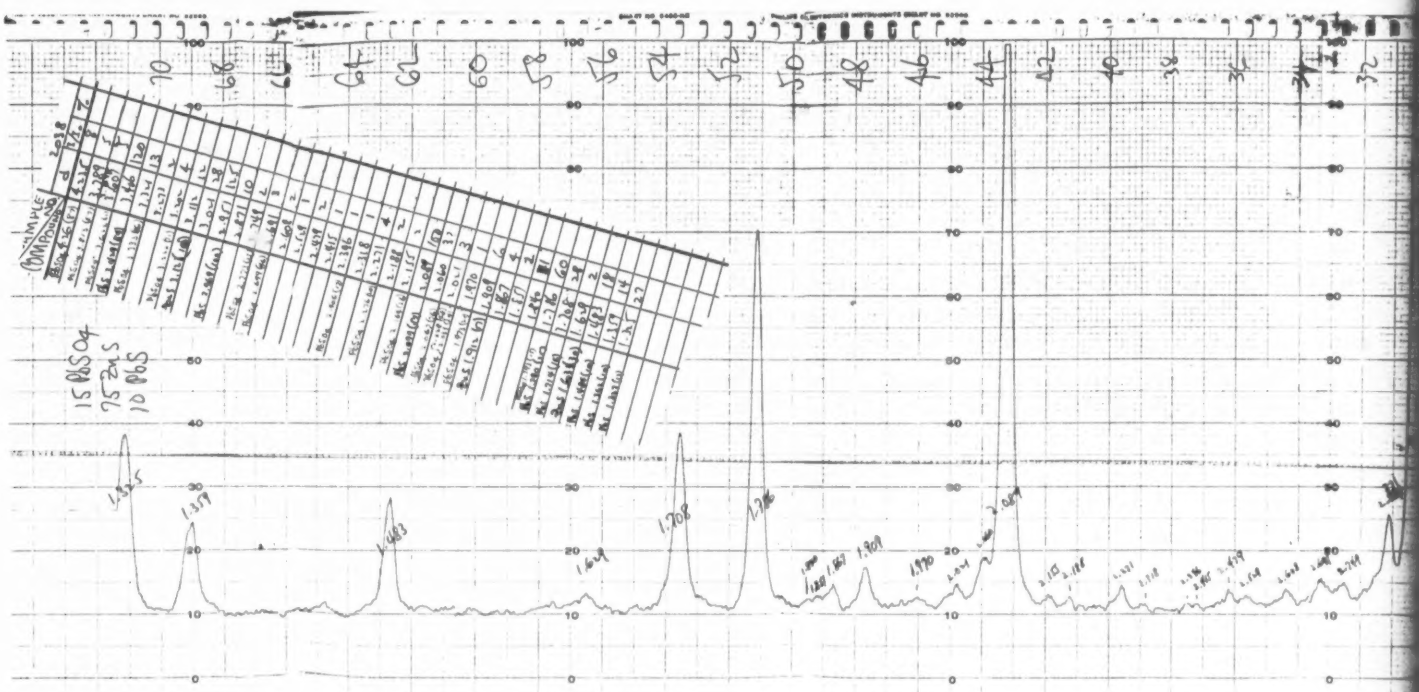


Figure G-9 - Run 7, Location 5, Filter 2038

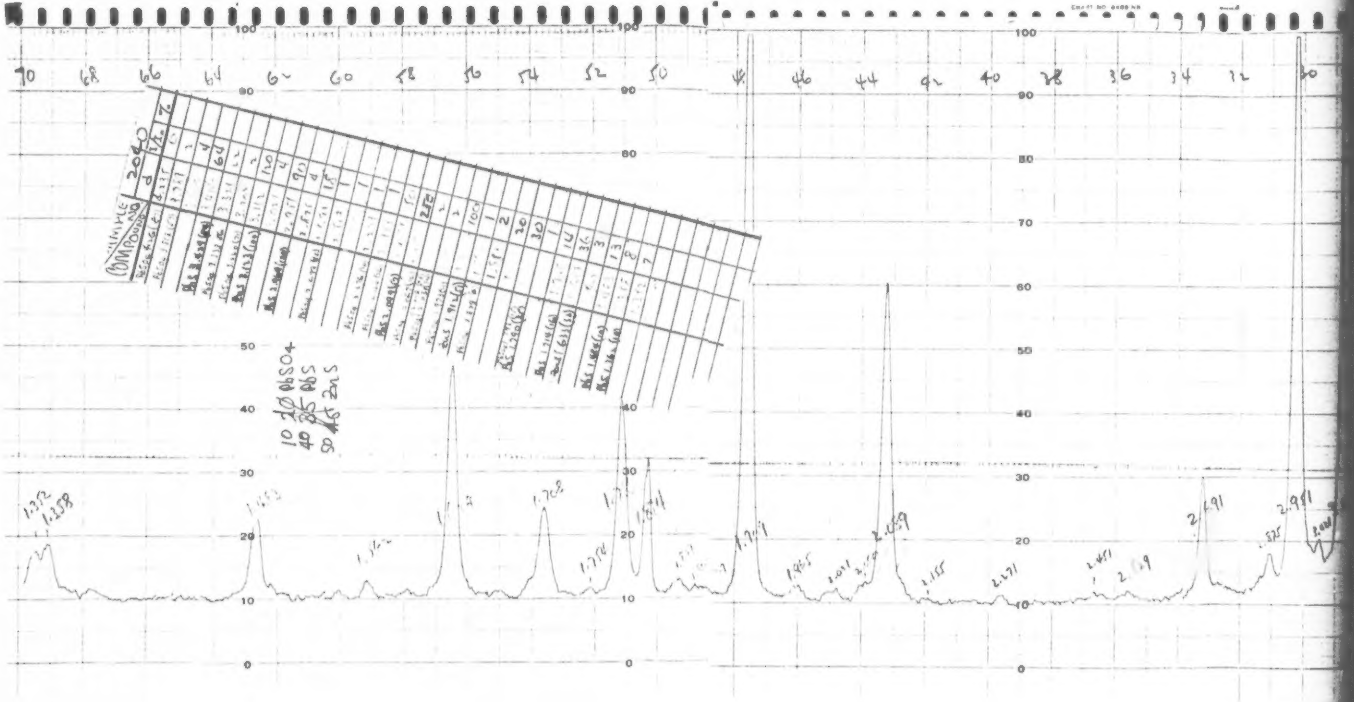
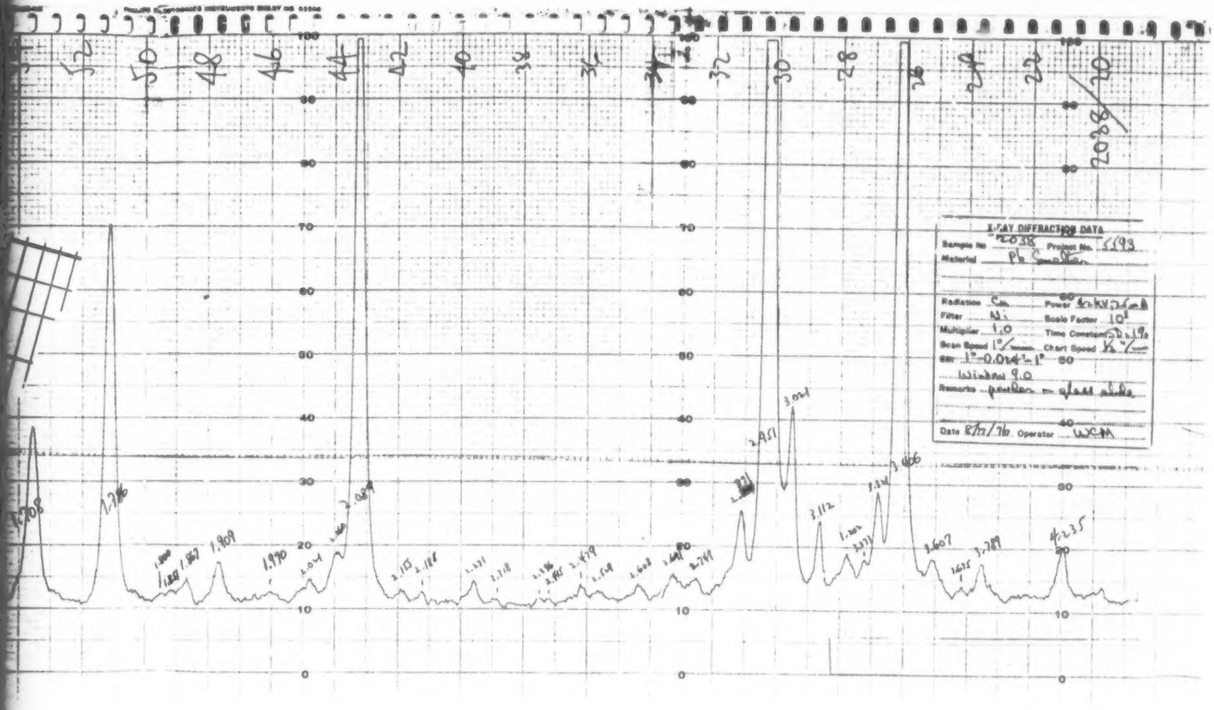


Figure G-10 - Run 8, Location 6N, Filter 2040


X-RAY DIFFRACTION DATA

Sample No. 2038 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42 kV, 20 mA

Filter Ni Scale Factor 10³

Multiplier 1.0 Time Constant SD-1%

Scan Speed 1°/min Chart Speed ½"/min

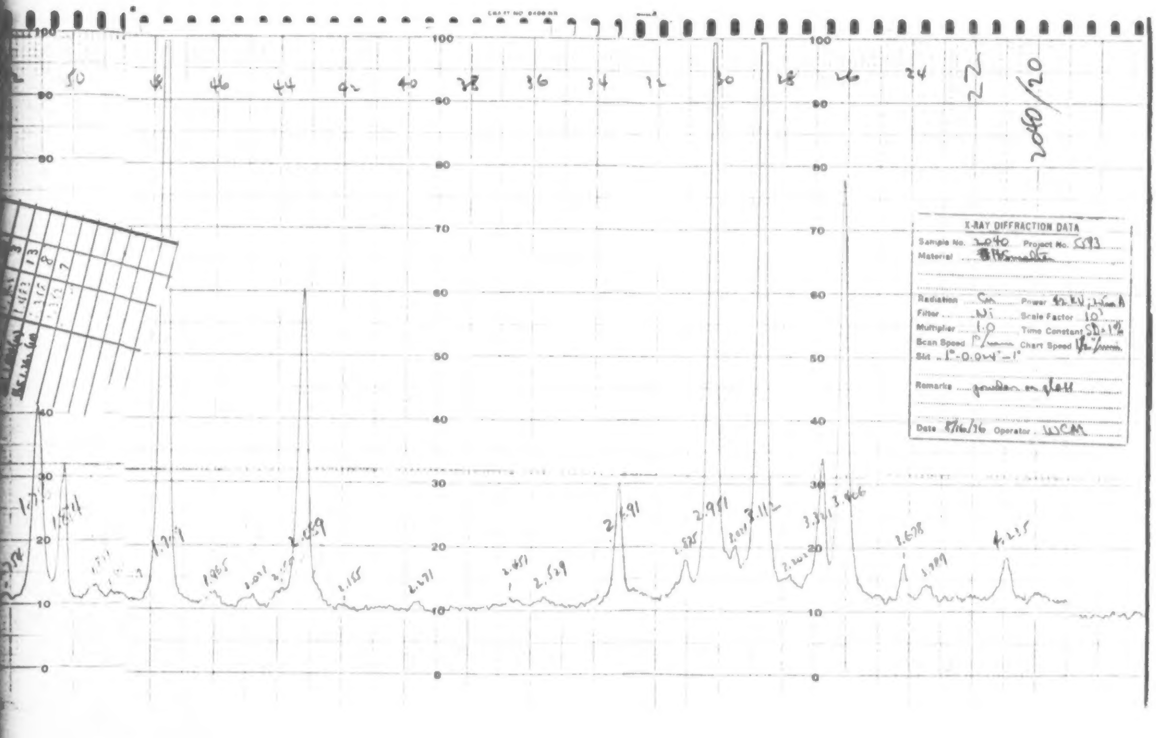
Slit 1°-0.004"-1°

Window 9.0

Remarks powder on glass slide

Date 8/17/76 Operator WCM

igure G-9 - Run 7, Location 5, Filter 2038


X-RAY DIFFRACTION DATA

Sample No. 2040 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42 kV, 20 mA

Filter Ni Scale Factor 10³

Multiplier 1.0 Time Constant SD-1%

Scan Speed 1°/min Chart Speed ½"/min

Slit 1°-0.004"-1°

Remarks powder on glass

Date 8/16/76 Operator WCM

ure G-10 - Run 8, Location 6N, Filter 2040

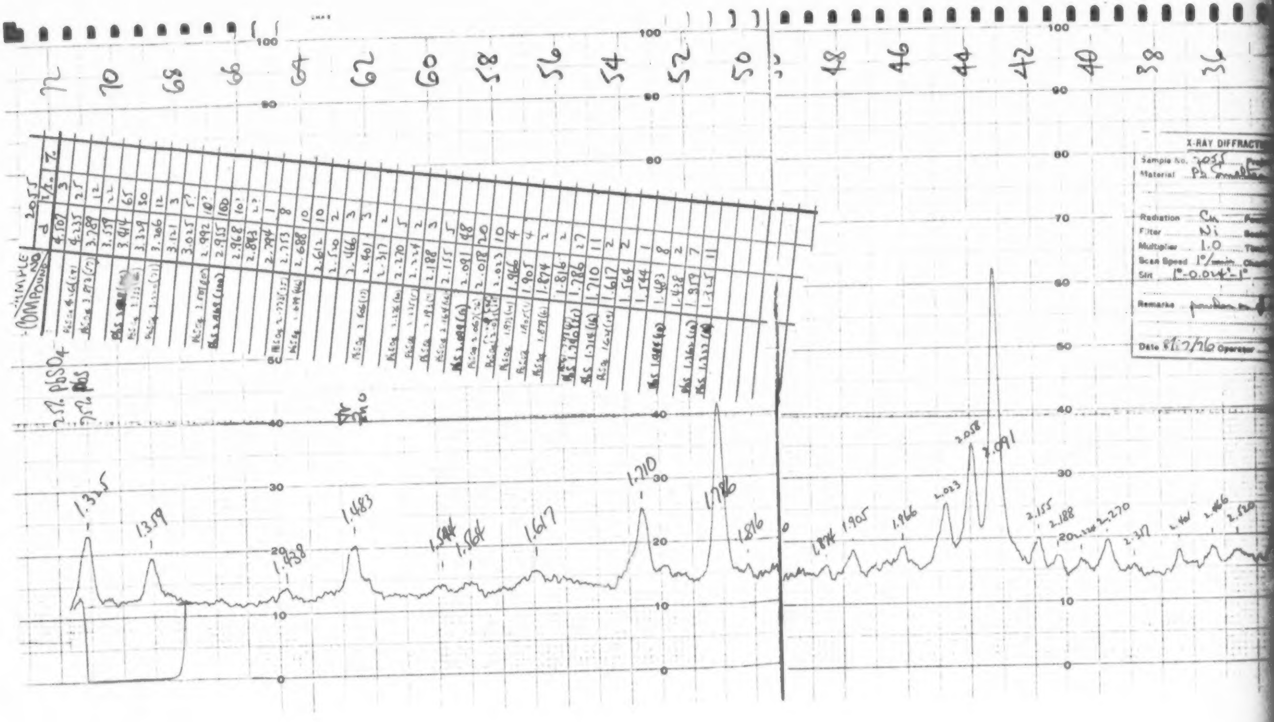


Figure G-11 - Run 12, Location 5A, Filter 2055

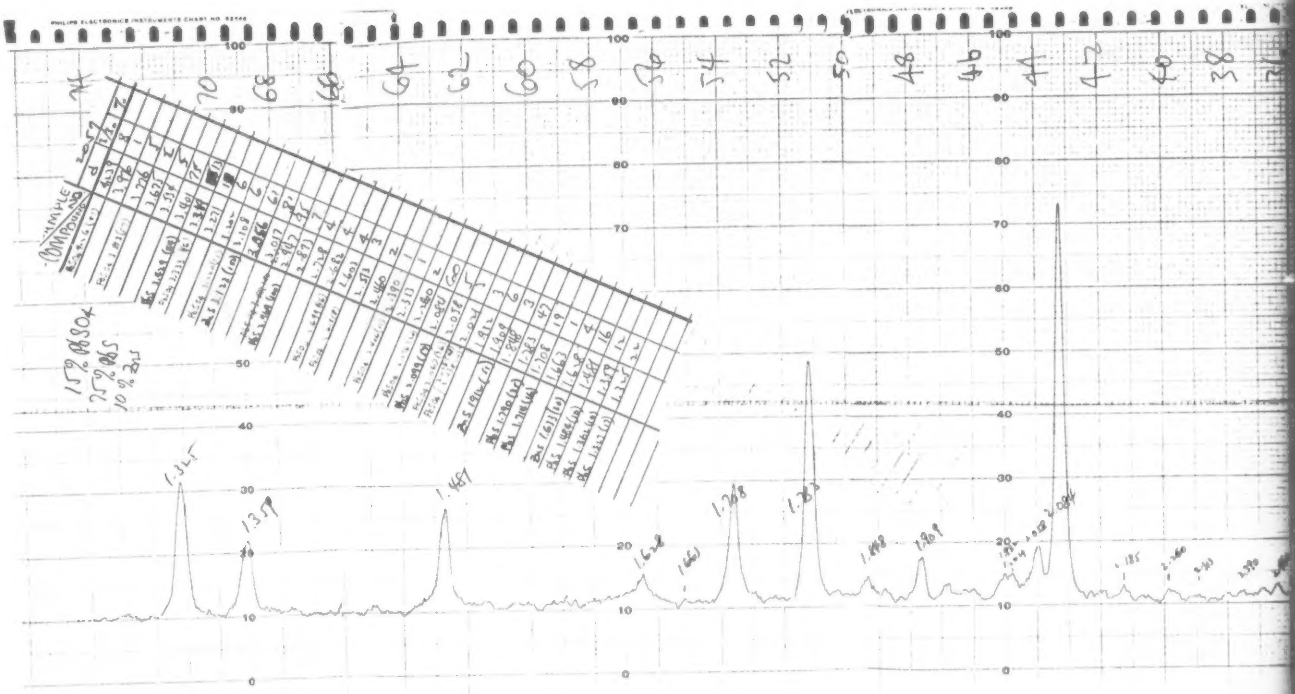
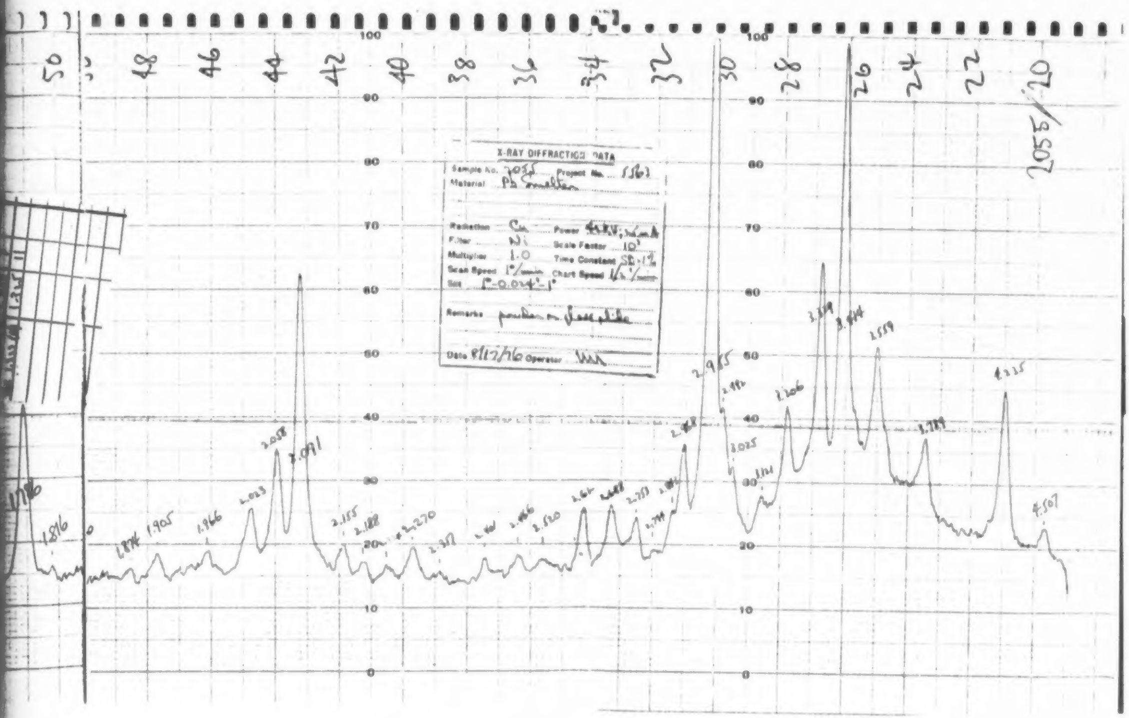


Figure G-12 - Run 12, Location 4A, Filter 2057



X-RAY DIFFRACTION DATA

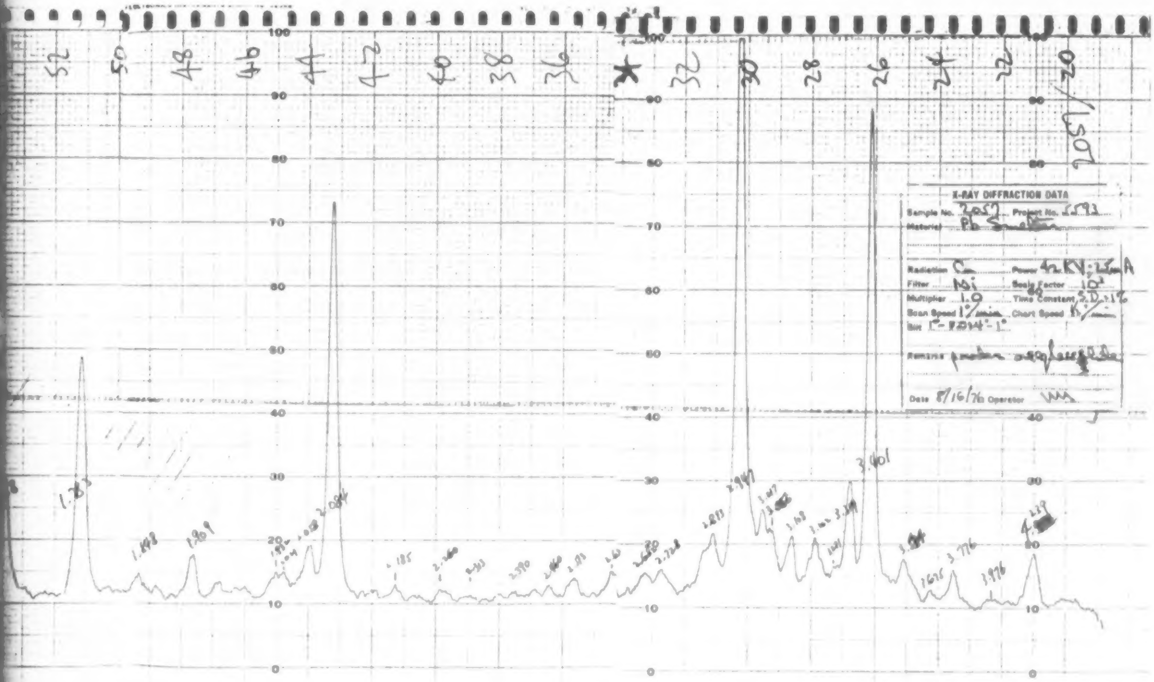
Sample No. 2055 Project No. 5563
Material Pb smelter

Radiation Cu Power 45KV; 20mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD-1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.004"-1°

Remarks powder on glass slide

Date 8/17/76 Operator WM

-11 - Run 12, Location 5A, Filter 2055



X-RAY DIFFRACTION DATA

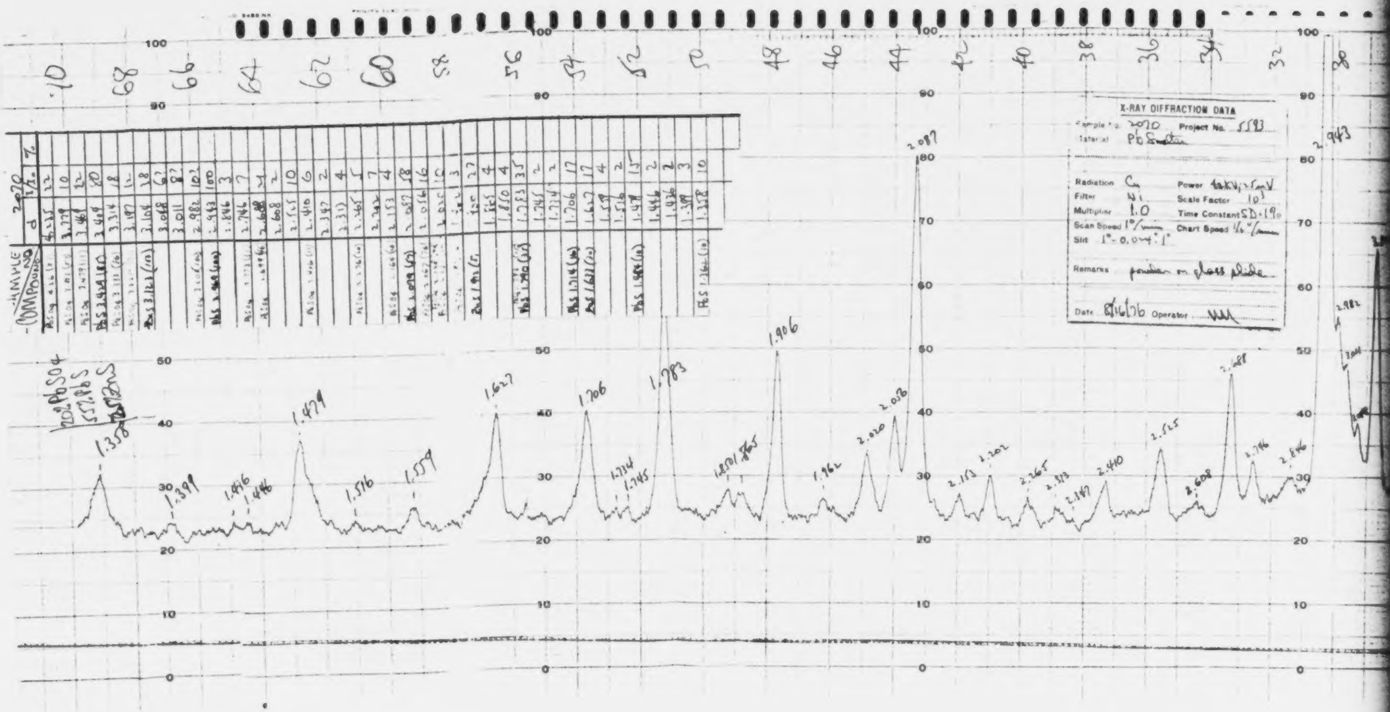
Sample No. 2057 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant S.D.-1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.004"-1°

Remarks powder on glass slide

Date 8/16/76 Operator WM

-12 - Run 12, Location 4A, Filter 2057



X-RAY DIFFRACTION DATA

Sample No. 2070 Project No. 5593

Material Pb Smelter

Radiation Cu Power 40kV; 25mA

Filter Ni Scale Factor 10^3

Multiplier 1.0 Time Constant SD·19

Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.004"-1°

Remarks powder on glass slide

Date 8/16/76

Figure G-13 - Run 21, Location 12, Filter 2070

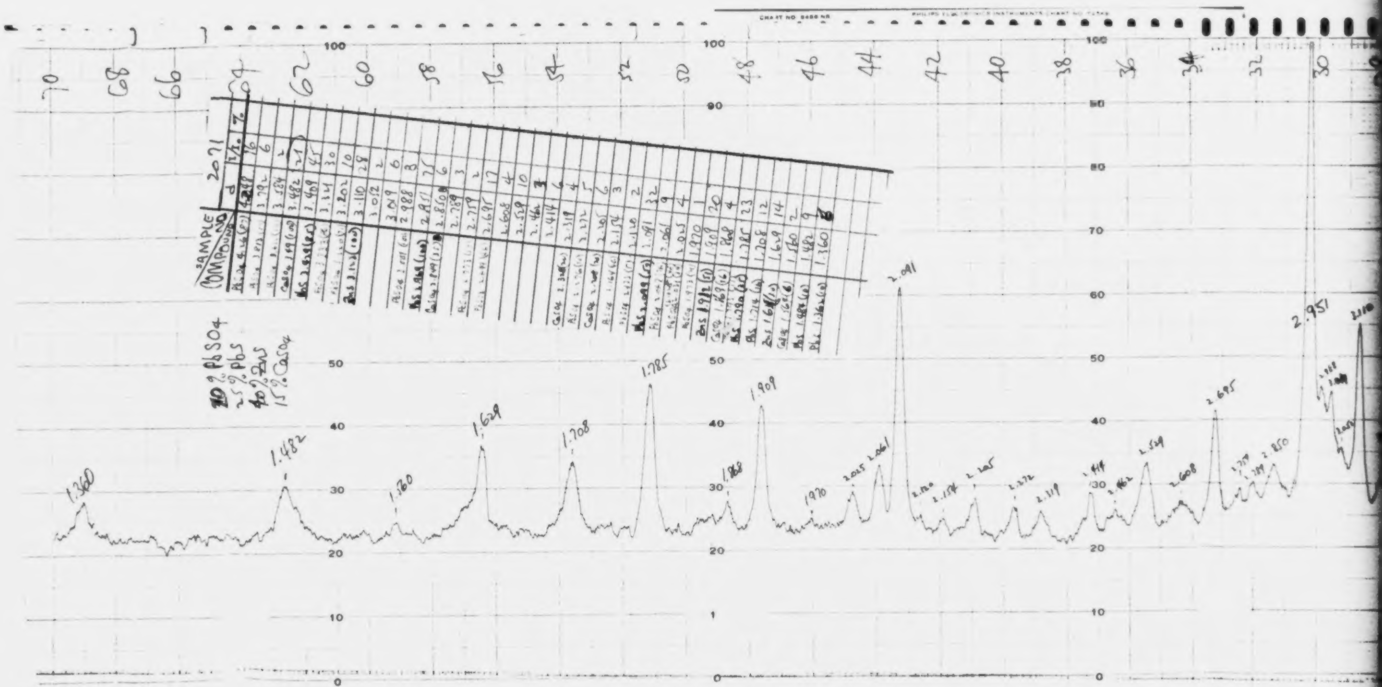
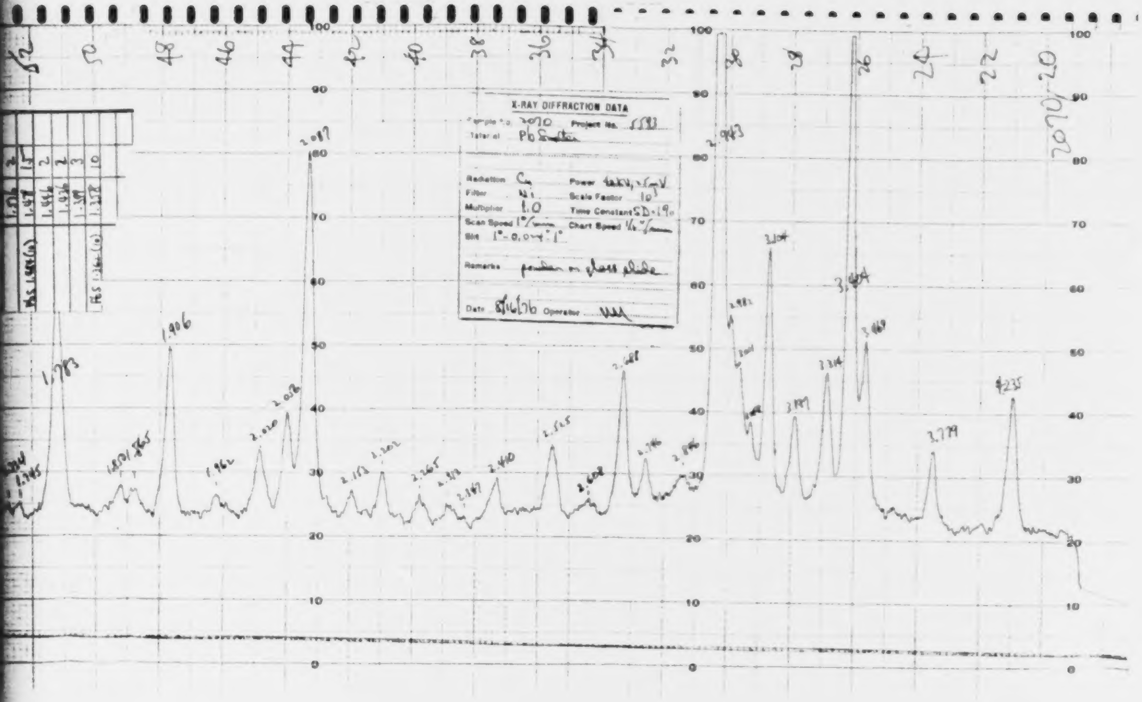


Figure G-14 - Run 21, Location 13, Backup, Filter 2071



X-RAY DIFFRACTION DATA

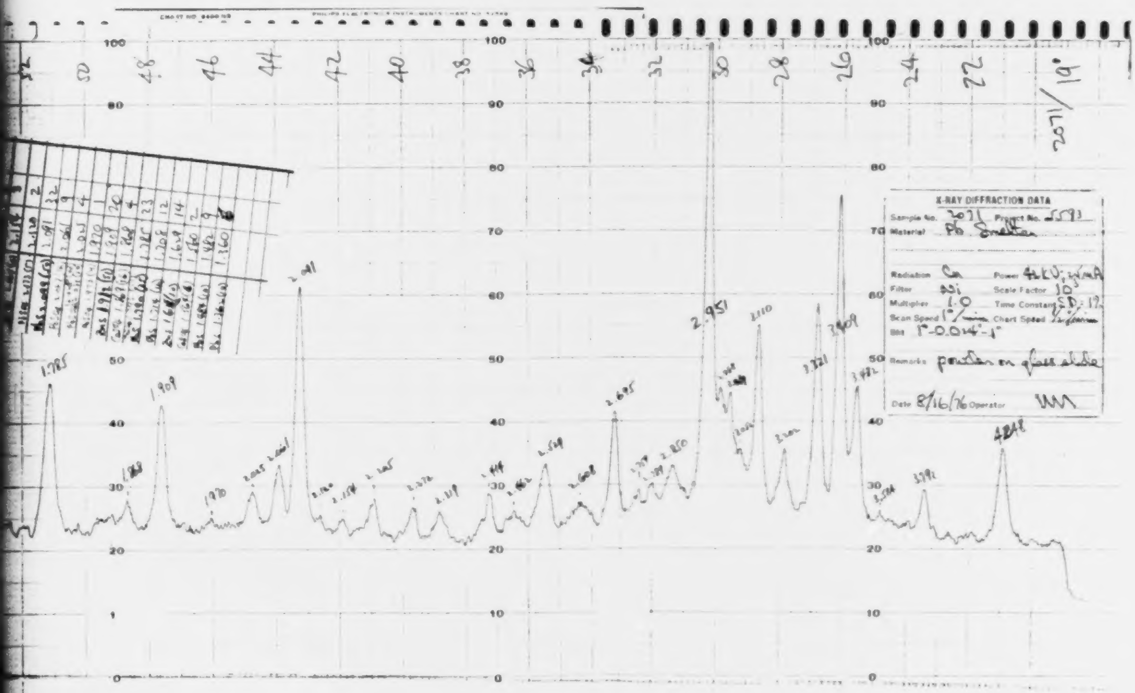
Sample No. 2070 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42kV, 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD-19
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.014°-1°

Remarks powder on glass slide

Date 8/16/76 Operator

e G-13 - Run 21, Location 12, Filter 2070



X-RAY DIFFRACTION DATA

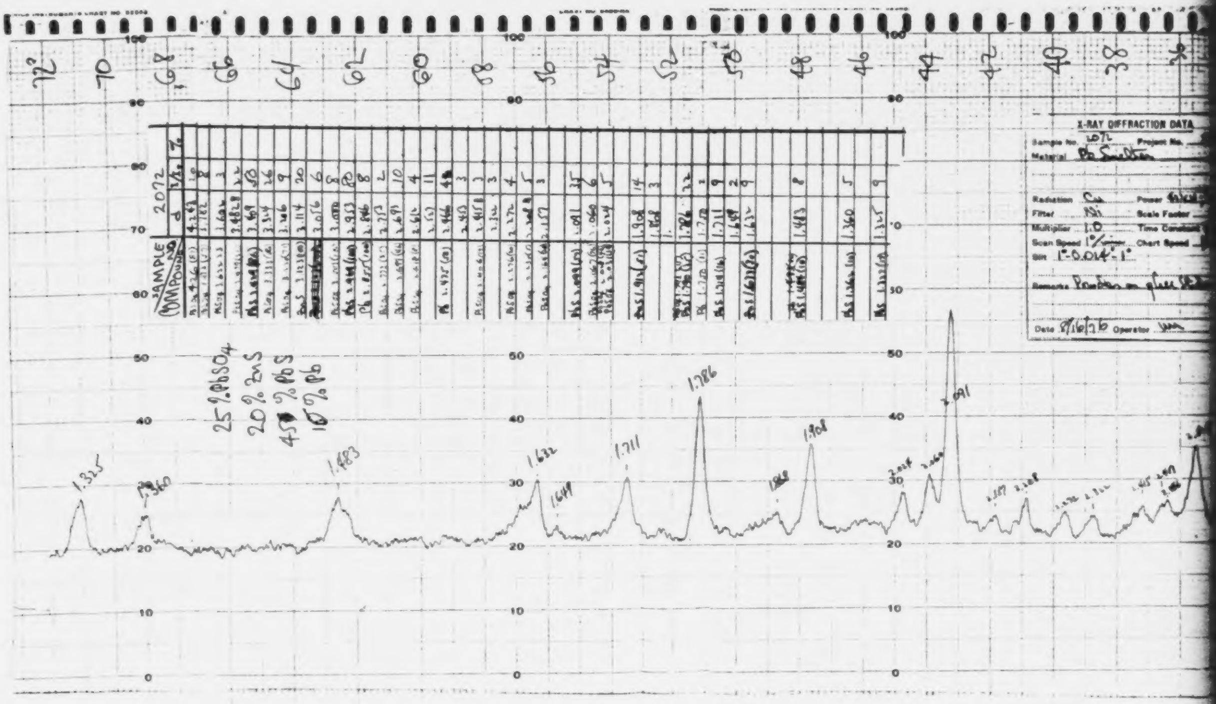
Sample No. 2071 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42kV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD-19
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.014°-1°

Remarks powder on glass slide

Date 8/16/76 Operator

-14 - Run 21, Location 13, Backup, Filter 2071



X-RAY DIFFRACTION DATA

Sample No. 2072

Project No.

Material Pb Smelter

Radiation Cu

Power

Filter Ni

Scale Factor

Multiplier 1.0

Time Constant

Scan Speed 1°/min

Chart Speed

Slit 1°-0.014-1°

Remarks Powder on glass slide

Date 8/16/76

Operator

Figure G-15 - Run 21, Location 14, Filter 2072

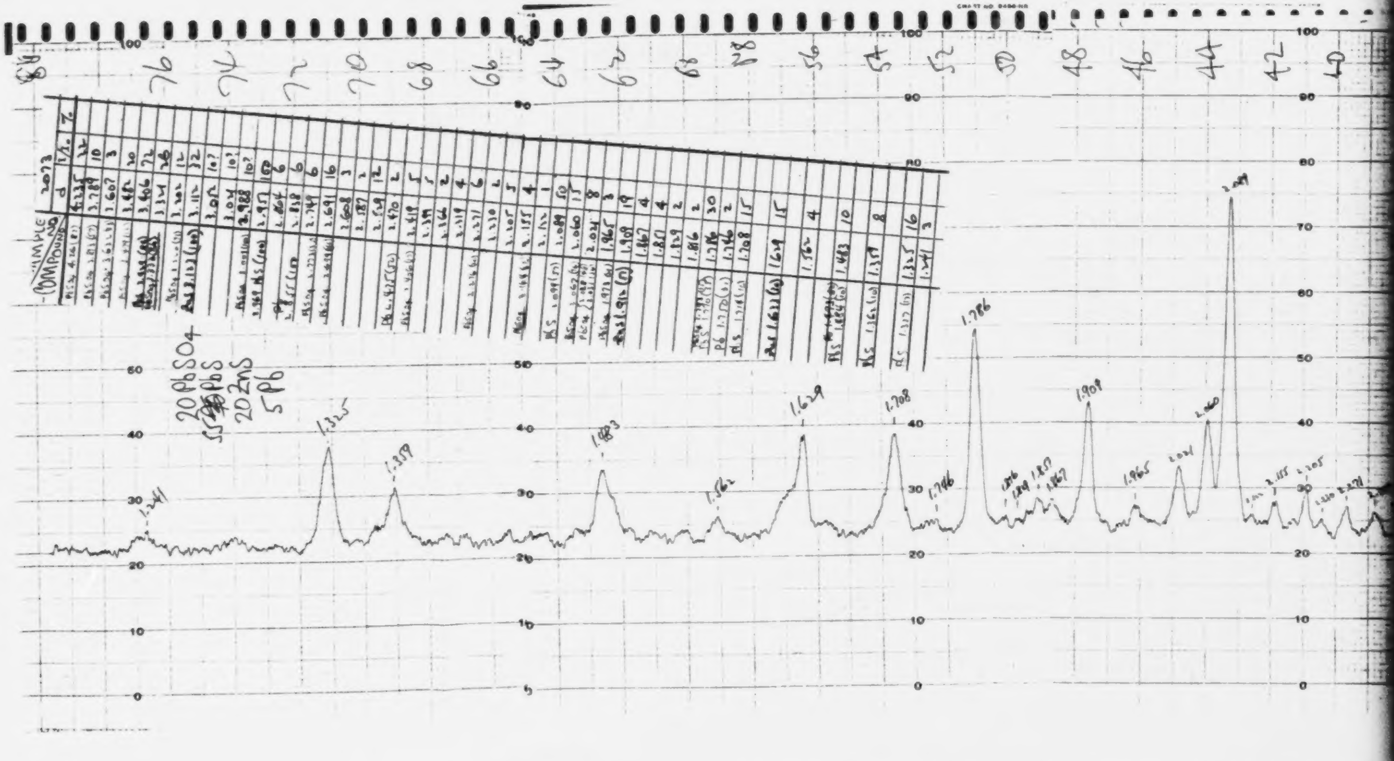
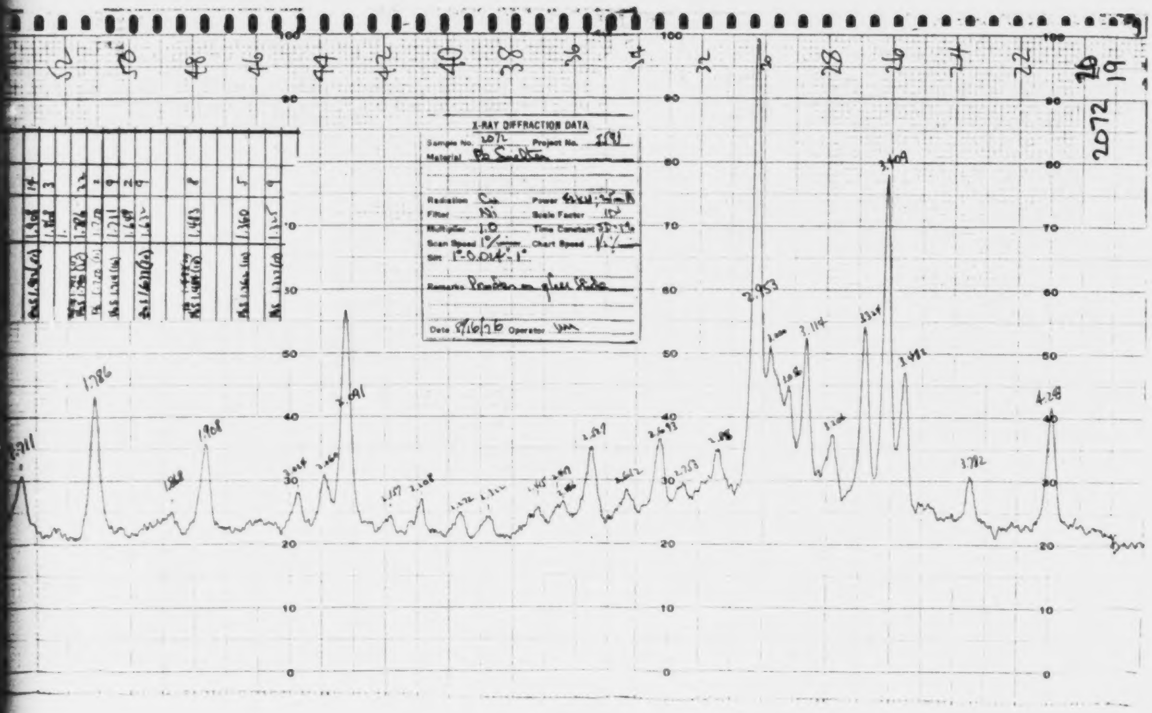


Figure G-16 - Run 21, Location 15, Filter 2073



X-RAY DIFFRACTION DATA

Sample No. 2072 Project No. 5593

Material Pb Smelter

Radiation Cu Power 45KV, 35mA

Filter Ni Scale Factor 10

Multiplier 1.0 Time Constant SD 1%

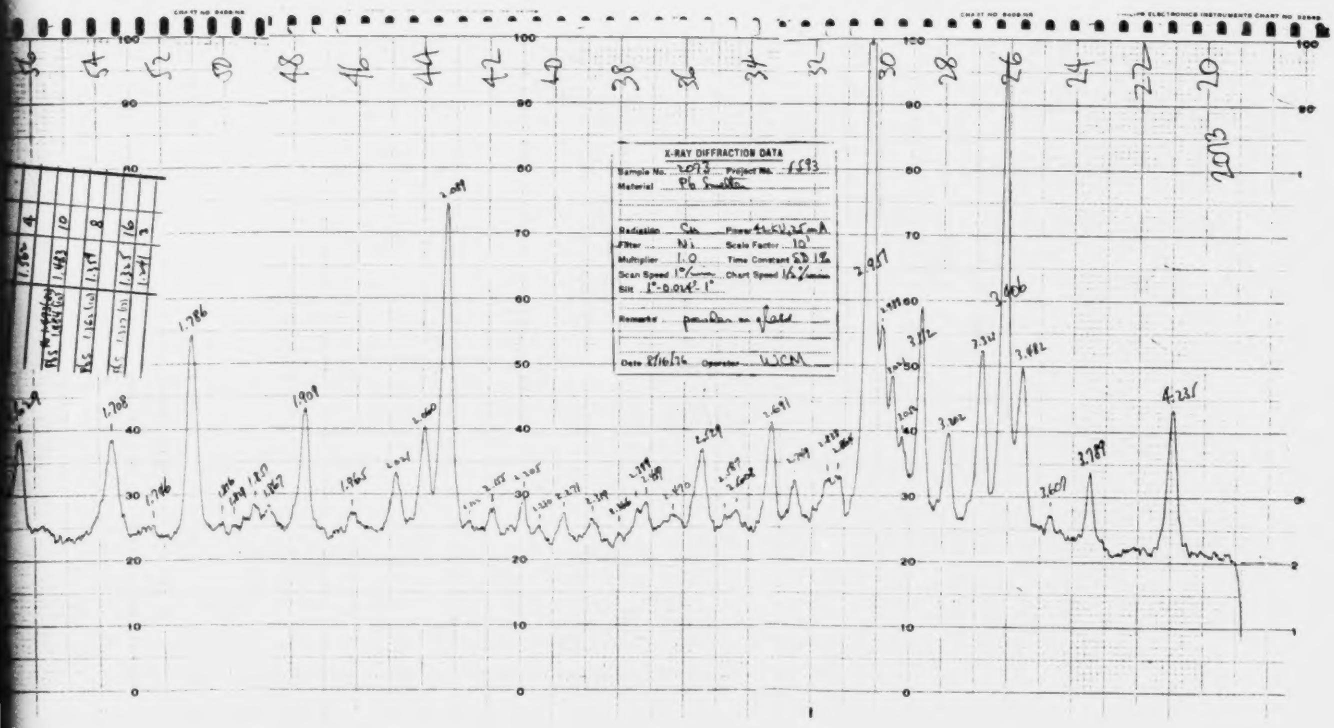
Scan Speed 1°/min Chart Speed ½°/min

Slit 1°-0.014"-1°

Remarks Powder on glass slide

Date 8/16/76 Operator WM

re G-15 - Run 21, Location 14, Filter 2072



X-RAY DIFFRACTION DATA

Sample No. 2073 Project No. 5593

Material Pb Smelter

Radiation Cu Power 45KV, 35mA

Filter Ni Scale Factor 10

Multiplier 1.0 Time Constant SD 1%

Scan Speed 1°/min Chart Speed ½°/min

Slit 1°-0.014"-1°

Remarks powder on glass

Date 8/16/76 Operator WCM

re G-16 - Run 21, Location 15, Filter 2073

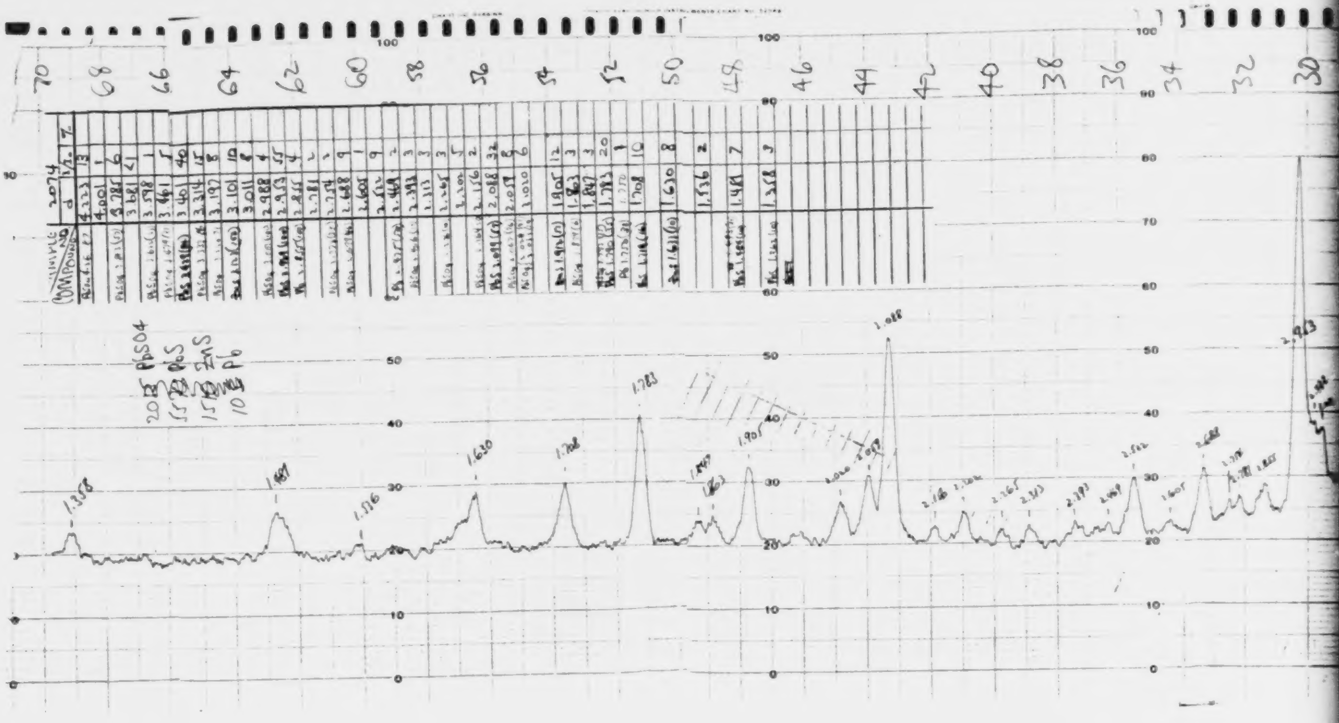


Figure G-17 - Run 21, Location 16, Filter 2074

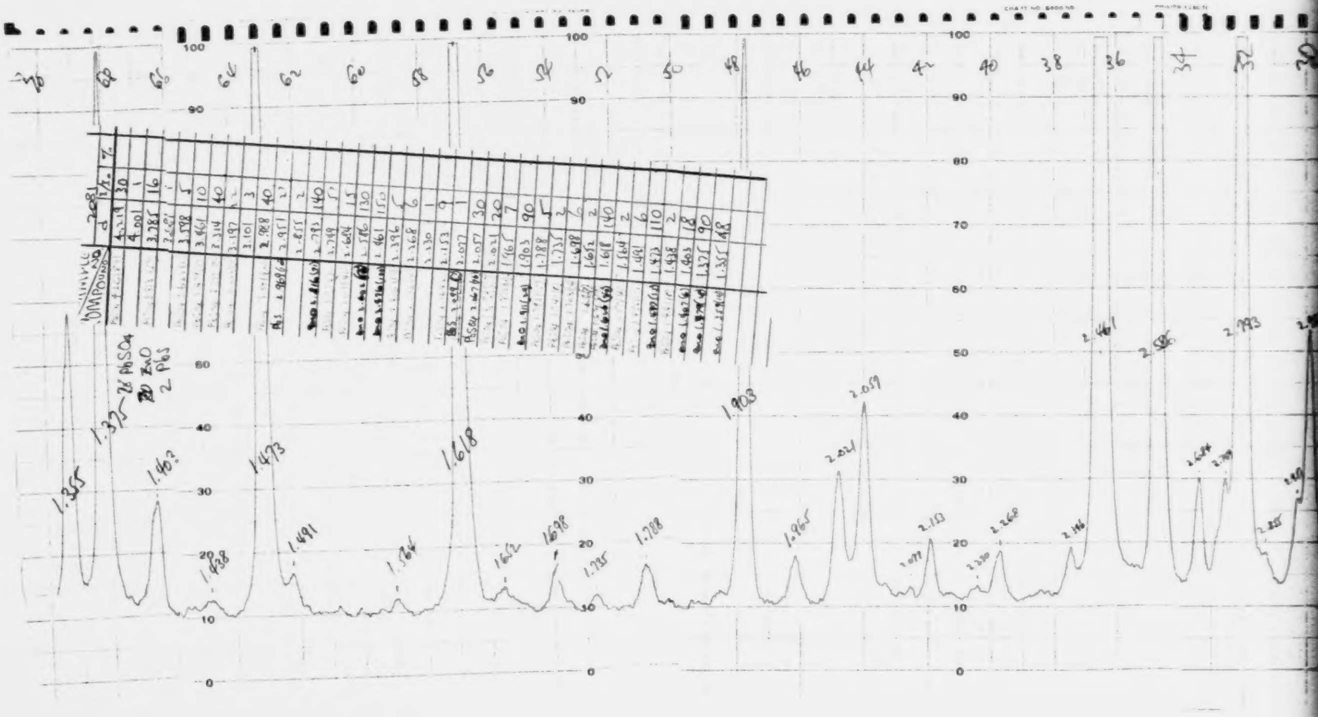
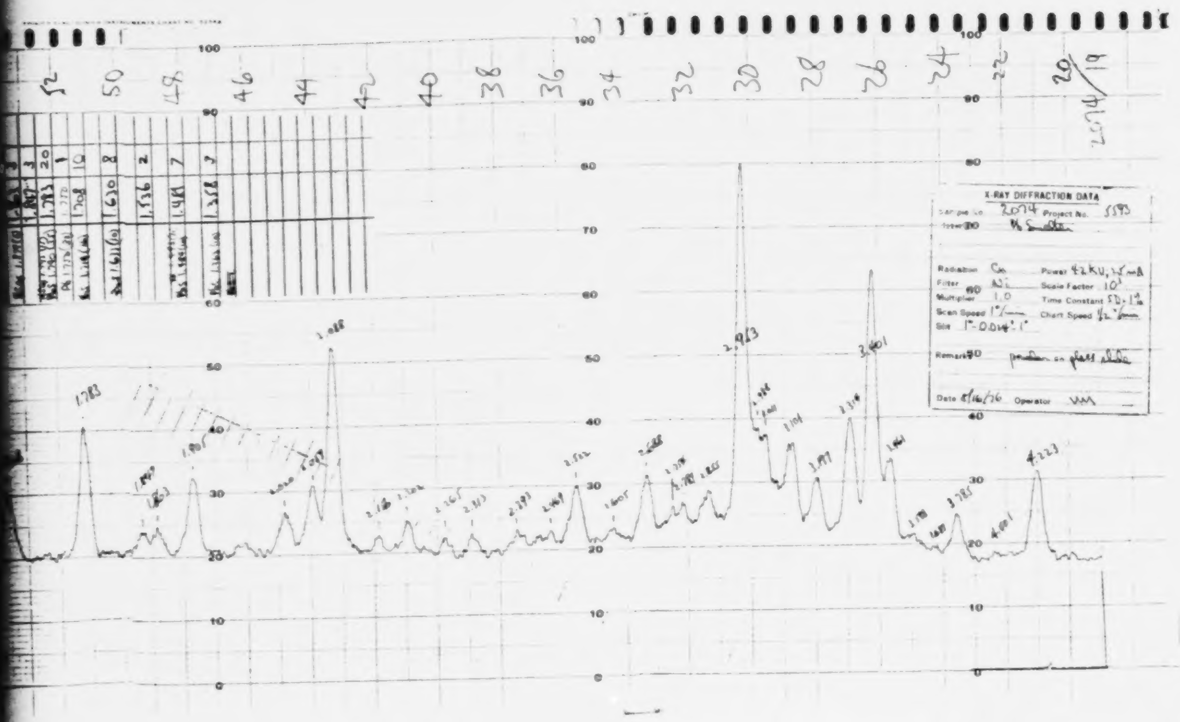
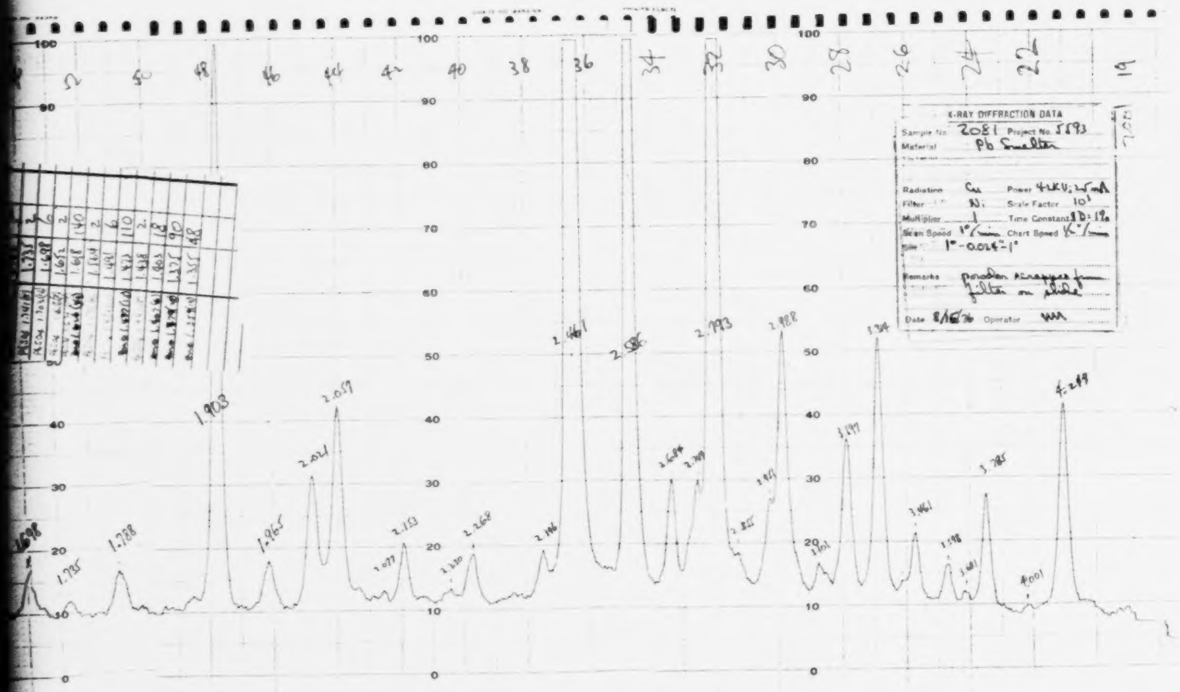


Figure G-18 - Run 23, Location 21, Filter 2081



X-RAY DIFFRACTION DATA
Sample No. 2074 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD-1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.014"-1°
Remarks powder on glass slide
Date 8/16/76 Operator VM

igure G-17 - Run 21, Location 16, Filter 2074



X-RAY DIFFRACTION DATA
Sample No. 2081 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1 Time Constant SD-1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.014"-1°
Remarks powder scraped from filter on slide
Date 8/16/76 Operator VM

Figure G-18 - Run 23, Location 21, Filter 2081

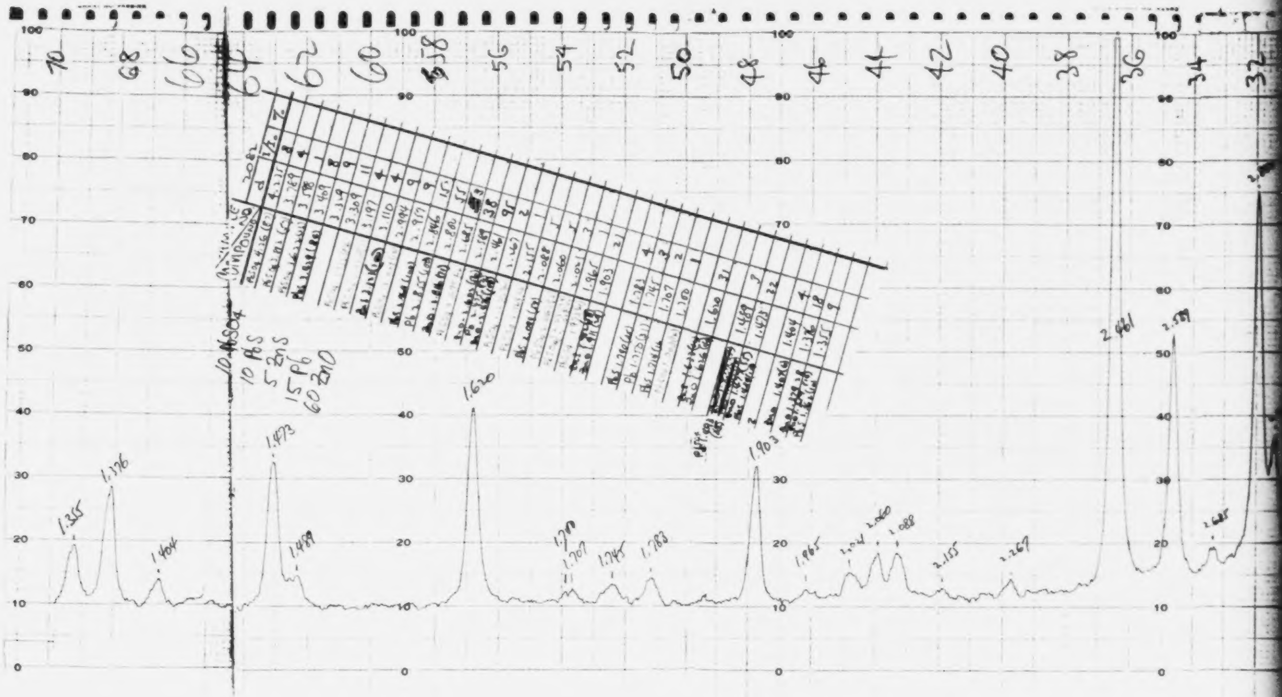


Figure G-19 - Run 23, Location 23, Filter 2082

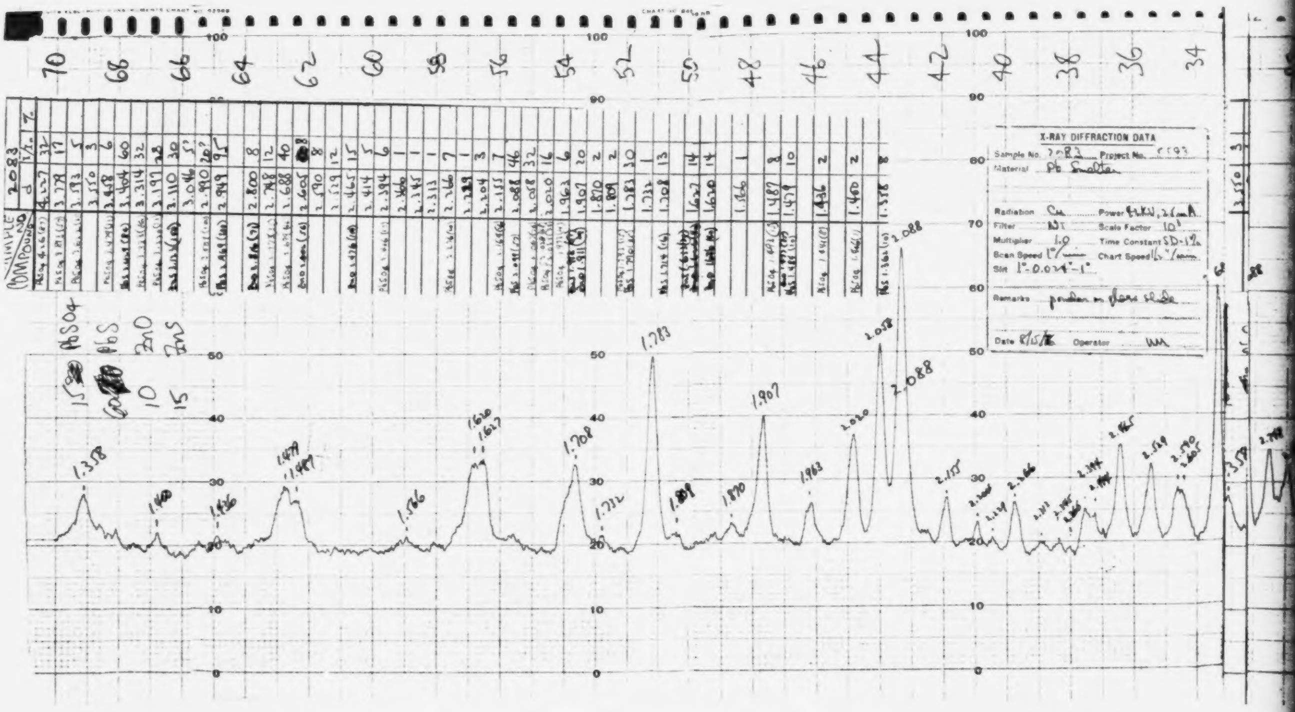
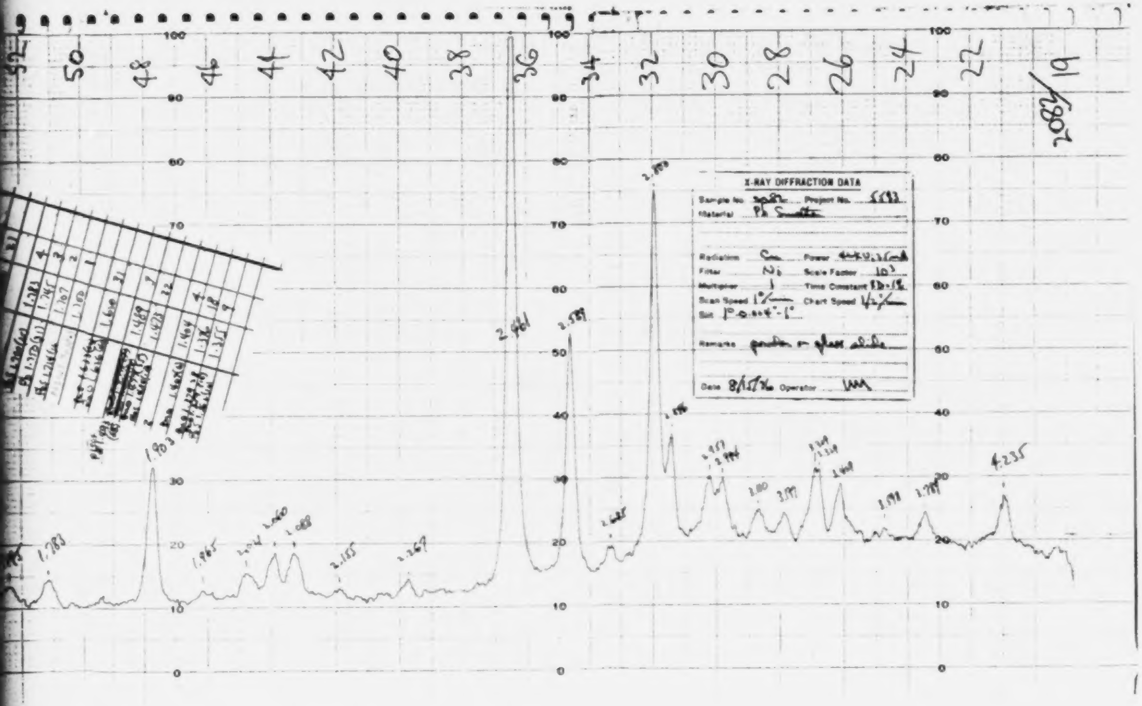


Figure G-20 - Run 23, Location 24N, Filter 2083



X-RAY DIFFRACTION DATA

Sample No. 2082 Project No. 5593

Material Pb Smelter

Radiation Cu Power 40kV; 26mA

Filter Ni Scale Factor 10^3

Multiplier 1 Time Constant SD-1%

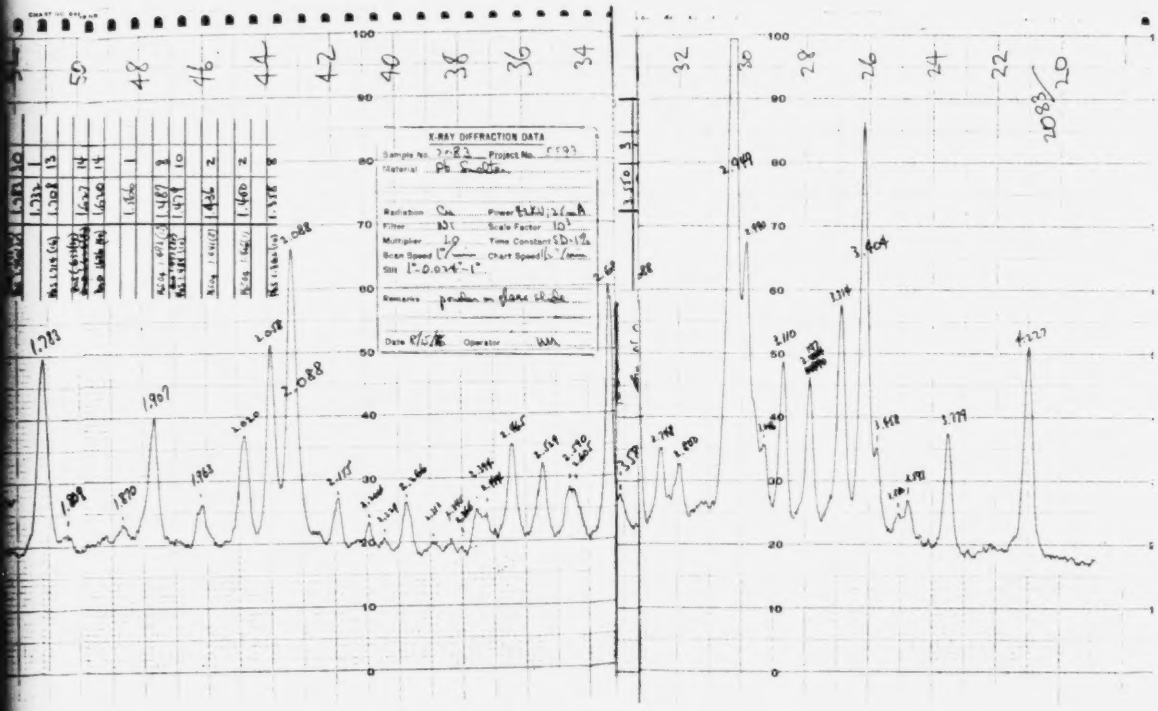
Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.004"-1°

Remarks powder on glass slide

Date 8/15/76 Operator WM

e G-19 - Run 23, Location 23, Filter 2082



X-RAY DIFFRACTION DATA

Sample No. 2083 Project No. 5593

Material Pb Smelter

Radiation Cu Power 35kV; 26mA

Filter Ni Scale Factor 10^3

Multiplier 1.0 Time Constant SD-1%

Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.074"-1°

Remarks powder on glass slide

Date 8/15/76 Operator WA

e G-20 - Run 23, Location 24N, Filter 2083

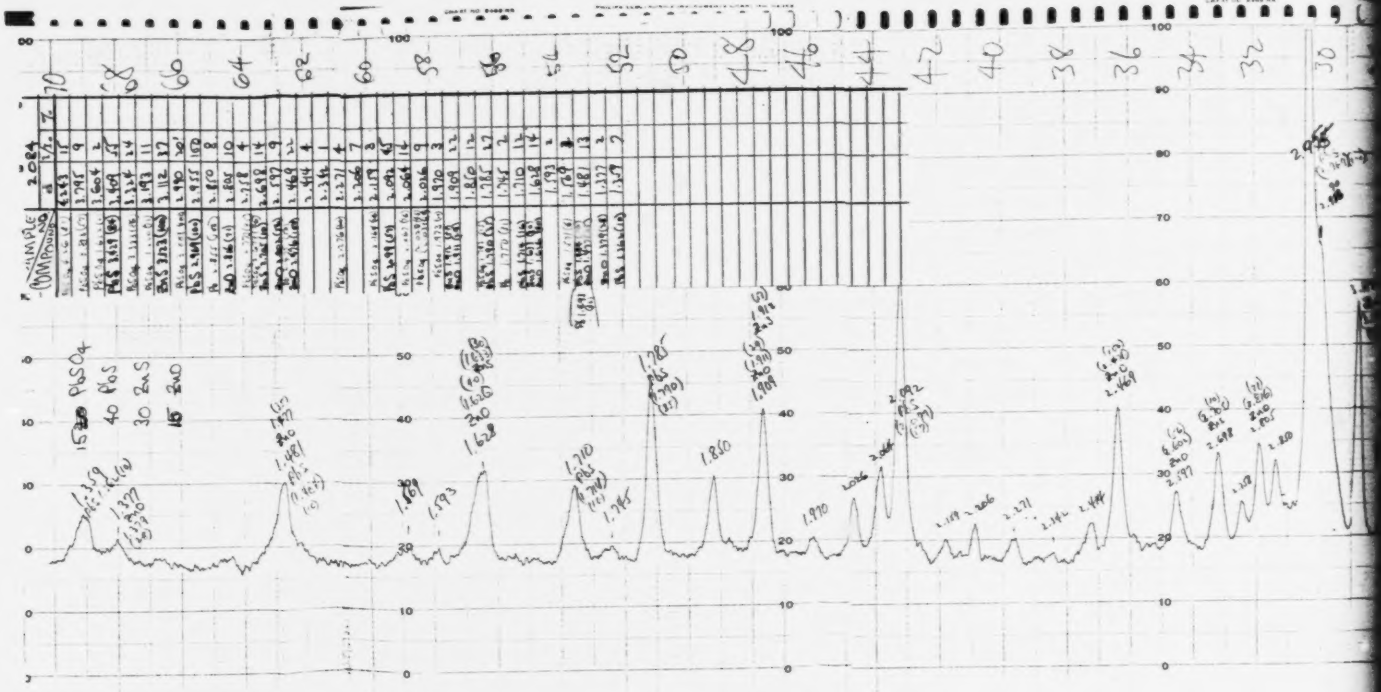
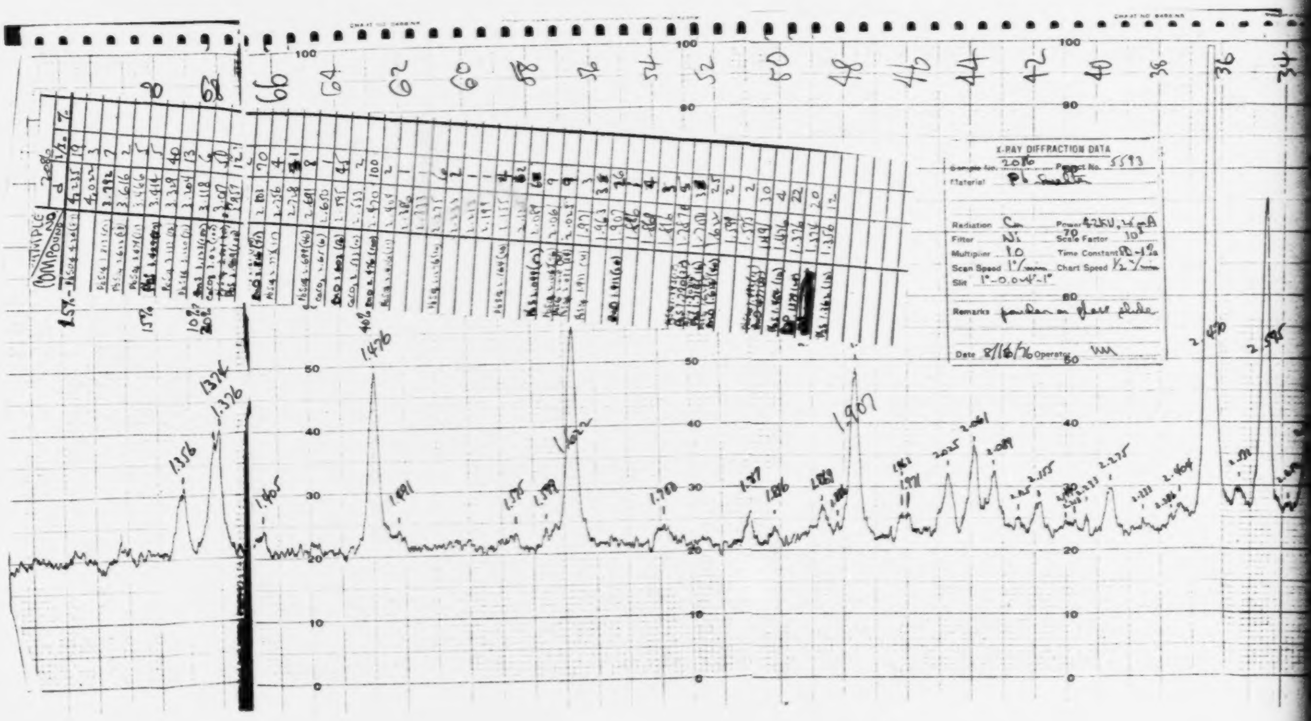


Figure G-21 - Run 23, Location 24S, Filter 2084



X-RAY DIFFRACTION DATA

Sample No. 2086 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV, 14mA

Filter Ni Scale Factor 70 10²

Multiplier 1.0 Time Constant

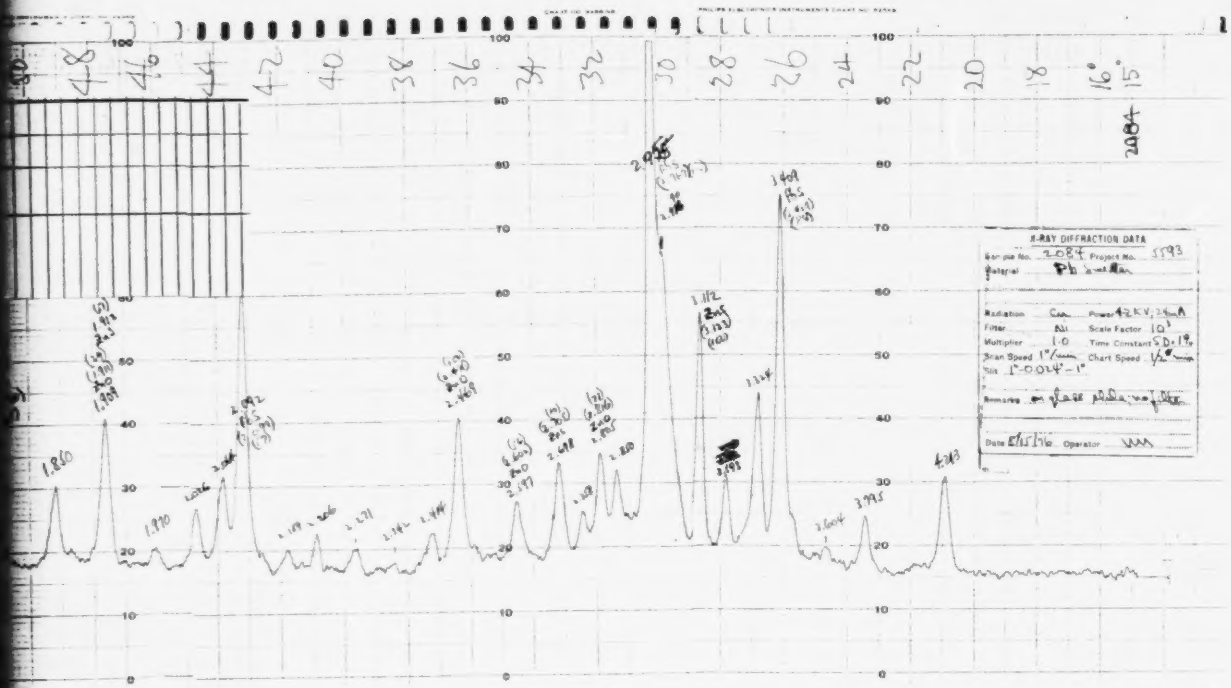
Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.004"-1°

Remarks powder on glass slide

Date 8/16/76 Operator

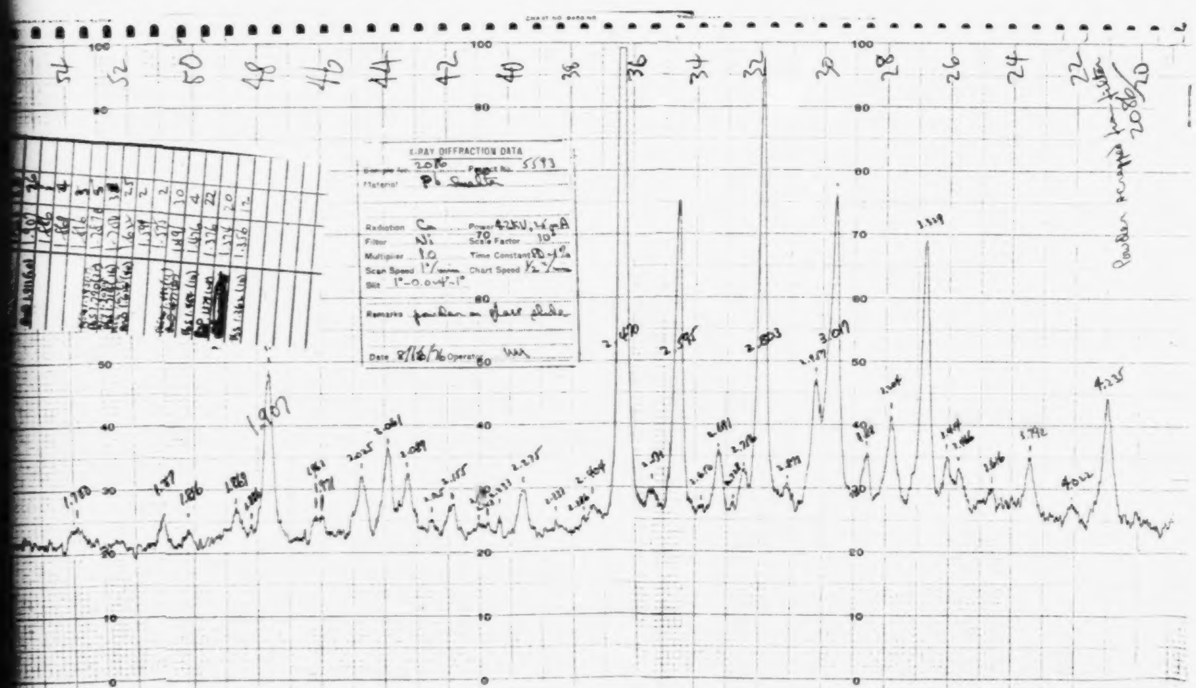
Figure G-22 - Run 23, Location 22, Filter 2086



X-RAY DIFFRACTION DATA

Sample No. 2084 Project No. 5593
Material Pb smelter
Radiation Cu Power 42KV, 24mA
Filter Ni Scale Factor 10^3
Multiplier 1.0 Time Constant SD 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.024°-1°
Remarks on glass slide; no filter
Date 8/15/76 Operator WM

re G-21 - Run 23, Location 24S, Filter 2084



X-RAY DIFFRACTION DATA

Sample No. 2086 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV, 26mA
Filter Ni Scale Factor 10^3
Multiplier 1.0 Time Constant SD 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.04°-1°
Remarks powder on glass slide
Date 8/16/76 Operator WM

ure G-22 - Run 23, Location 22, Filter 2086

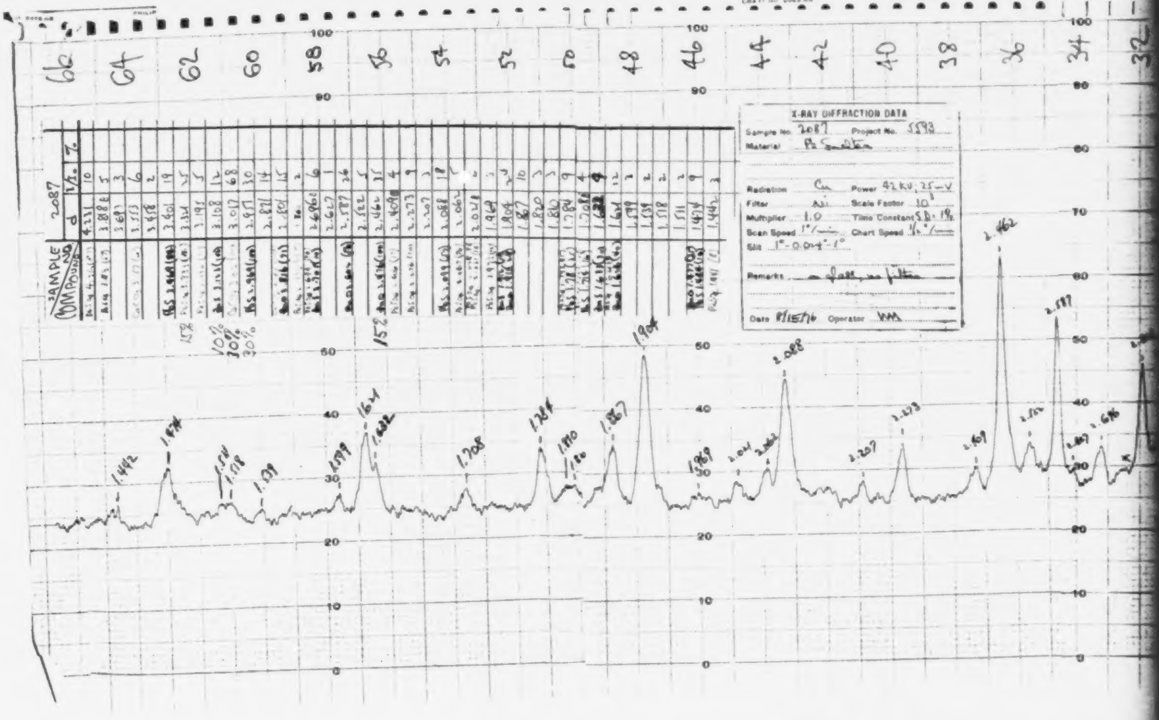


Figure G-23 - Run 23, Location 23A, Filter 2087

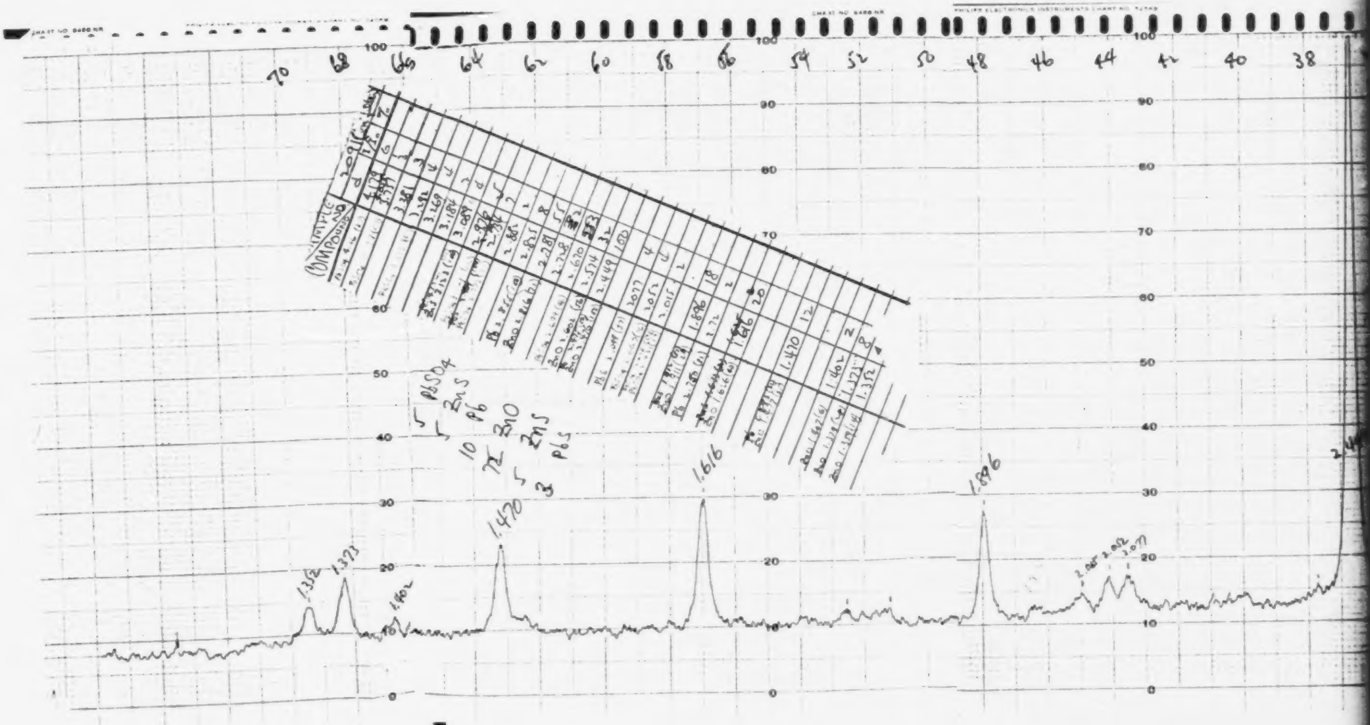
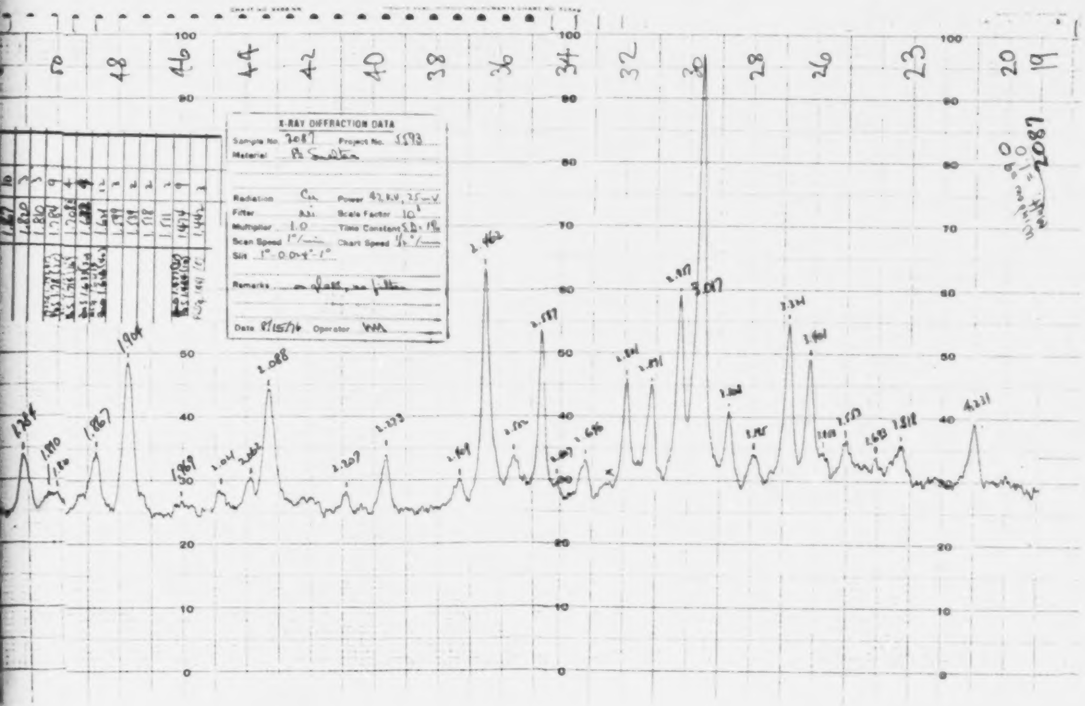


Figure G-24 - Run 26, Location 23, Backup, Filter



X-RAY DIFFRACTION DATA

Sample No. 2087 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42 KV, 25 mA

Filter Ni Scale Factor 10^1

Multiplier 1.0 Time Constant S.D. 1%

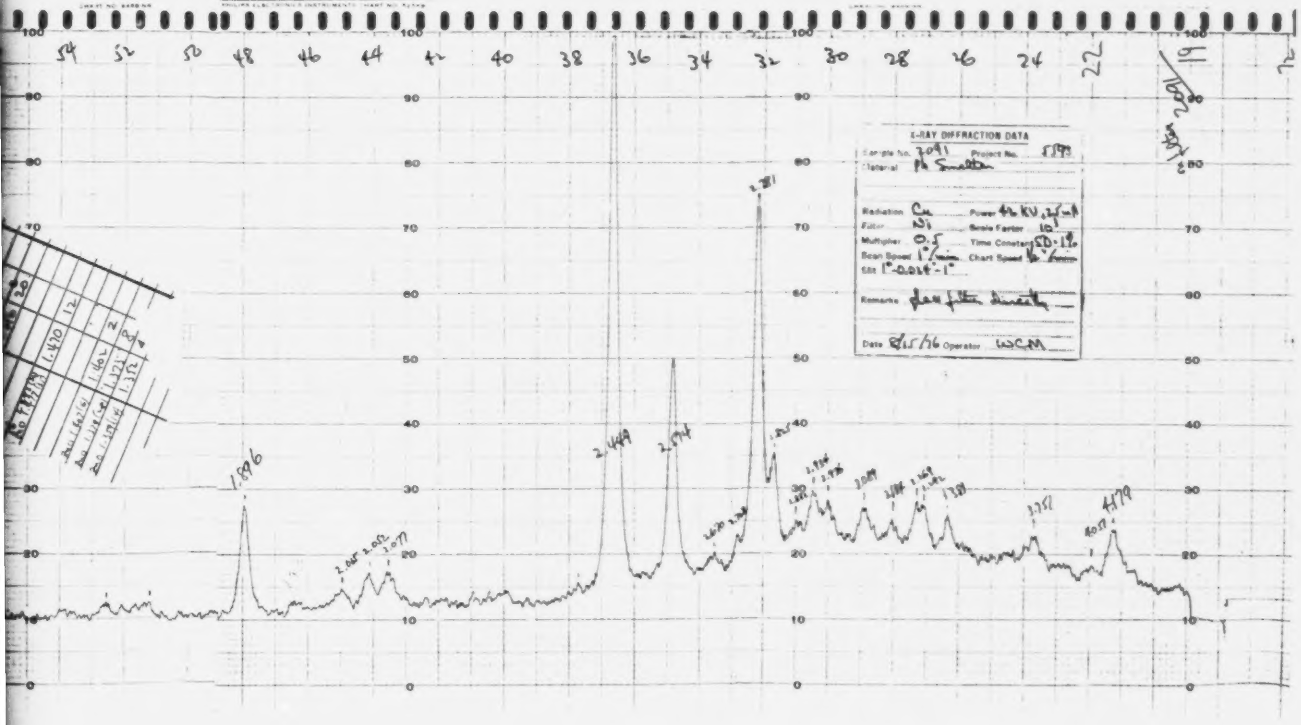
Scan Speed 1°/min Chart Speed 1/2°/min

Slit 1°-0.004°-1°

Remarks on glass, no filter

Date 8/15/76 Operator WM

ure G-23 - Run 23, Location 23A, Filter 2087



X-RAY DIFFRACTION DATA

Sample No. 2091 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42 KV, 25 mA

Filter Ni Scale Factor 10^1

Multiplier 0.5 Time Constant SD-1%

Scan Speed 1°/min Chart Speed 1/2°/min

Slit 1°-0.014°-1°

Remarks glass filter directly

Date 8/15/76 Operator WCM

G-24 - Run 26, Location 23, Backup, Filter 2091

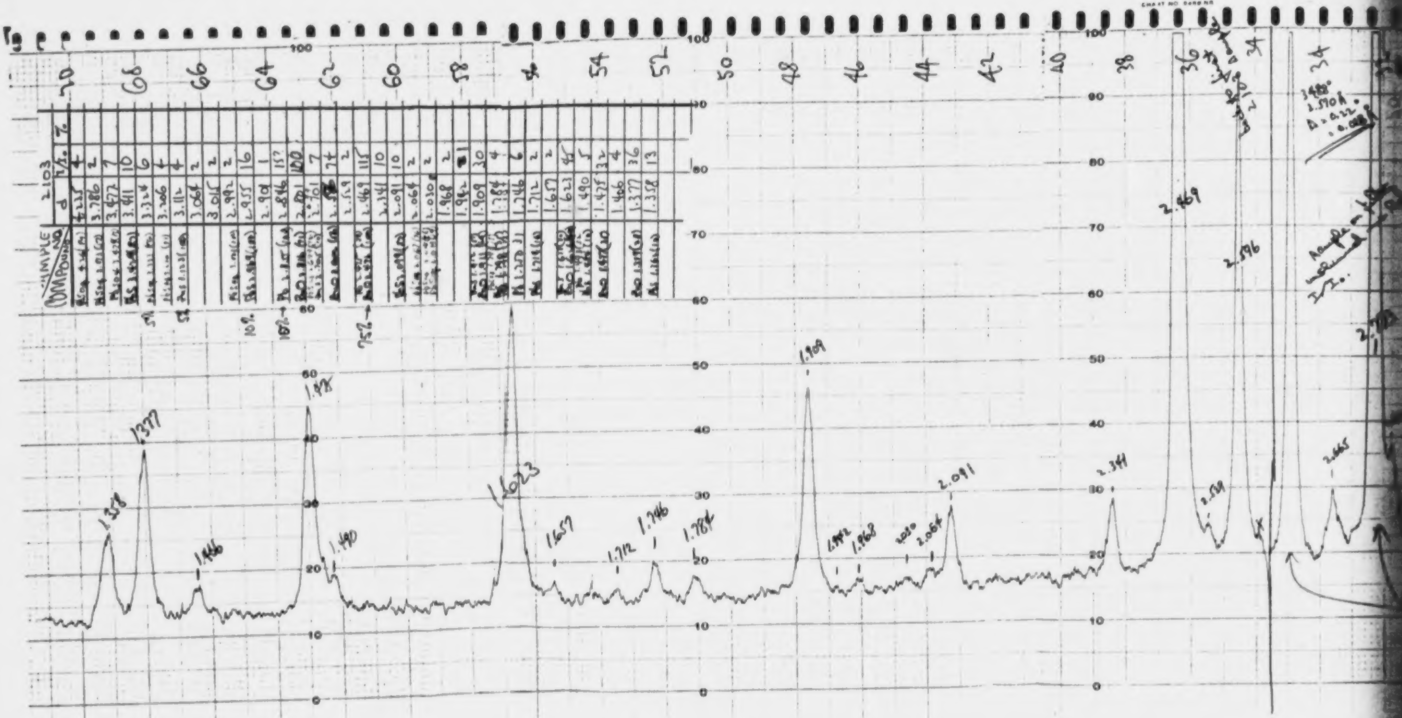


Figure G-25 - Run 28, Location 19, Filter 210

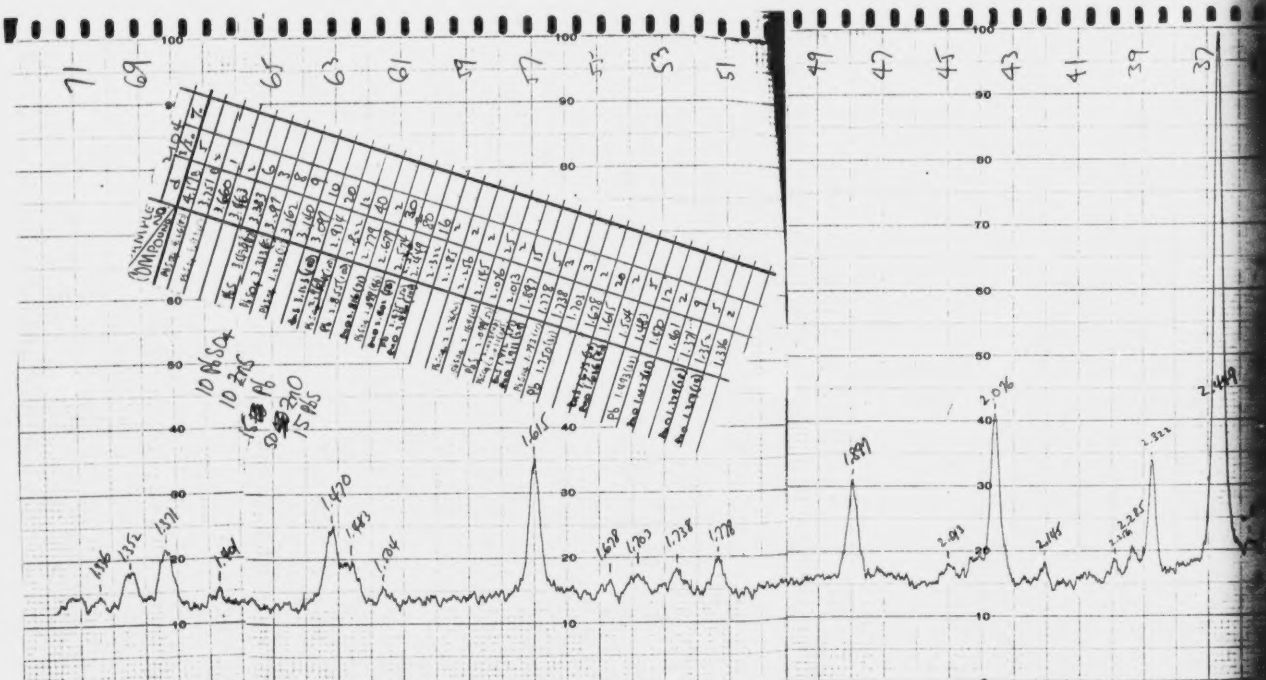
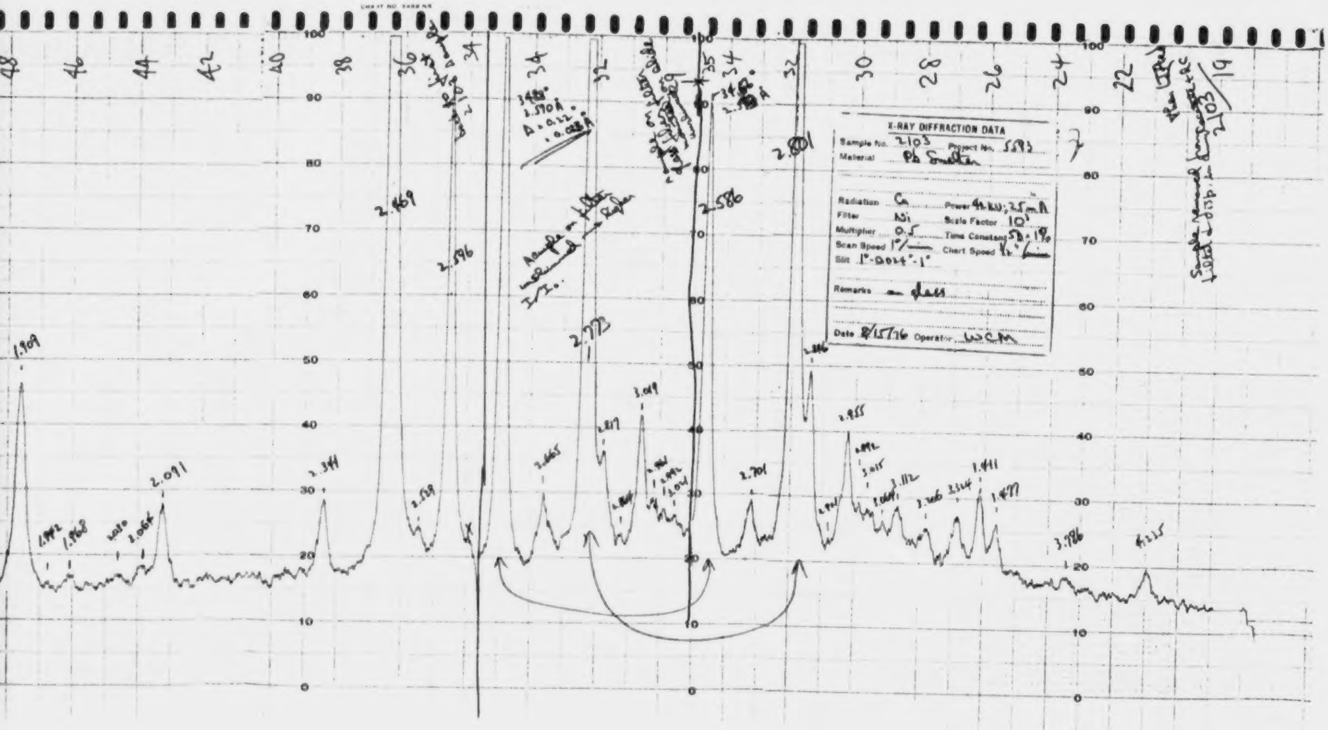


Figure G-26 - Run 28, Location 20, Filter 21



X-RAY DIFFRACTION DATA

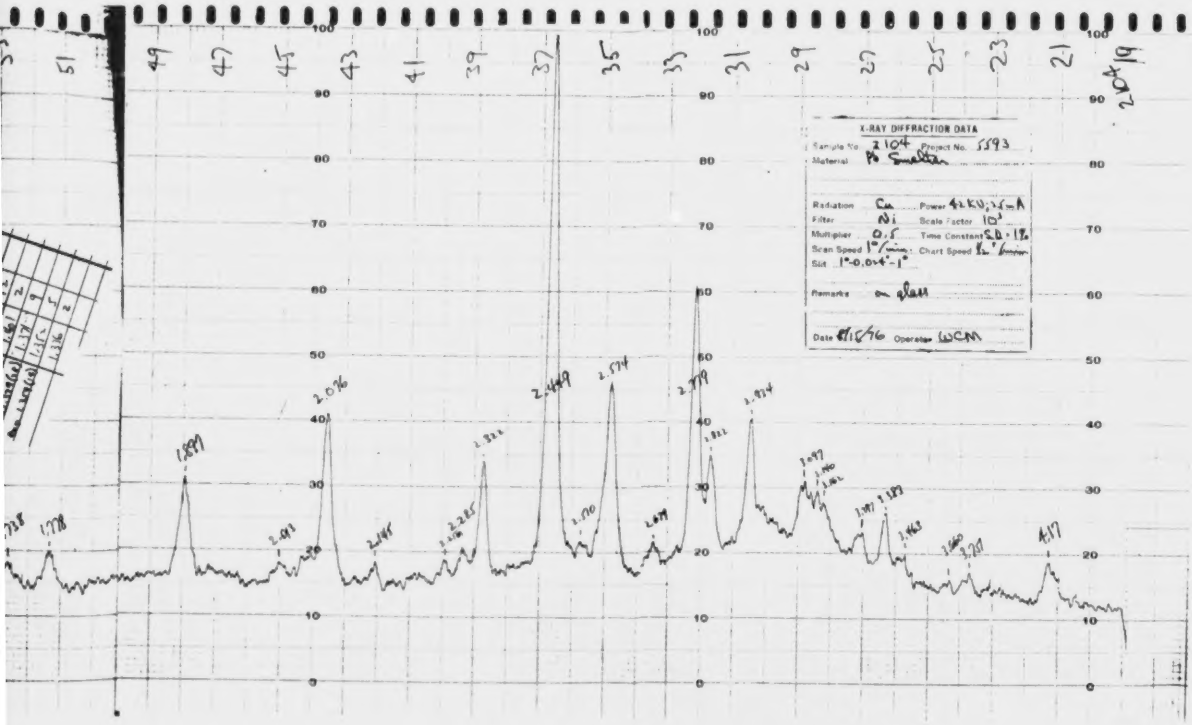
Sample No. 2103 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 0.5 Time Constant S.D. • 1%
Scan Speed 1°/min Chart Speed ½" /min
Slit 1°-0.024°-1°

Remarks on glass

Date 8/15/76 Operator WCM

ure G-25 - Run 28, Location 19, Filter 2103



X-RAY DIFFRACTION DATA

Sample No. 2104 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 0.5 Time Constant S.D. • 1%
Scan Speed 1°/min Chart Speed ½" /min
Slit 1°-0.024°-1°

Remarks on glass

Date 8/15/76 Operator WCM

:e G-26 - Run 28, Location 20, Filter 2104

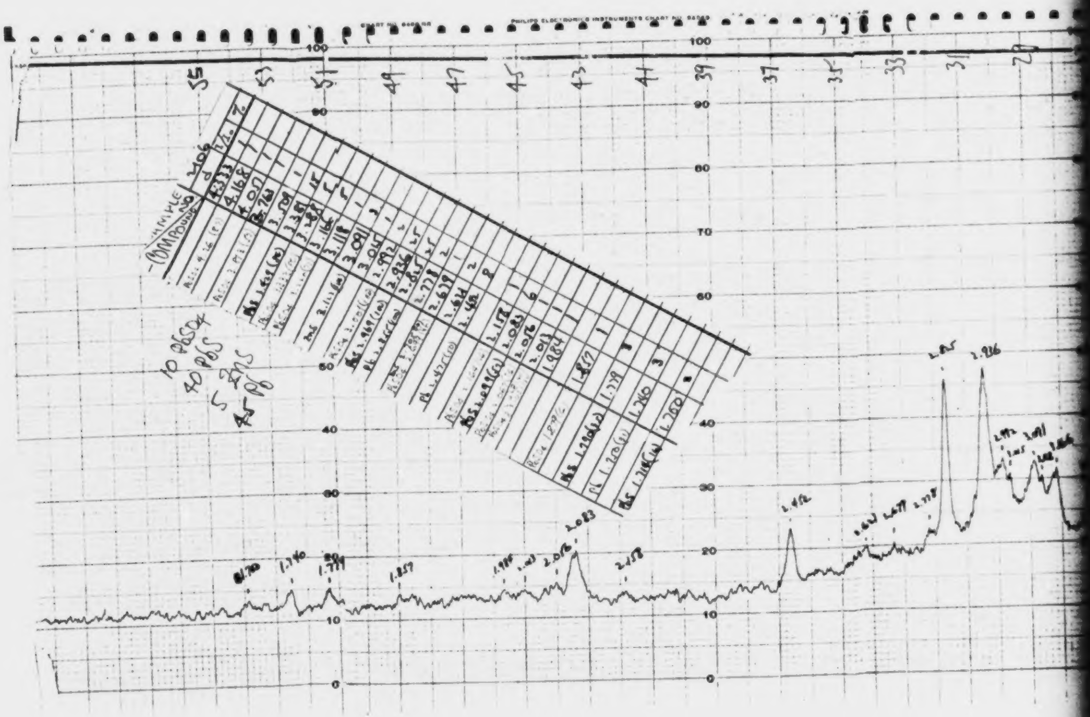


Figure G-27 - Run 28, Location 17, Filter 2106

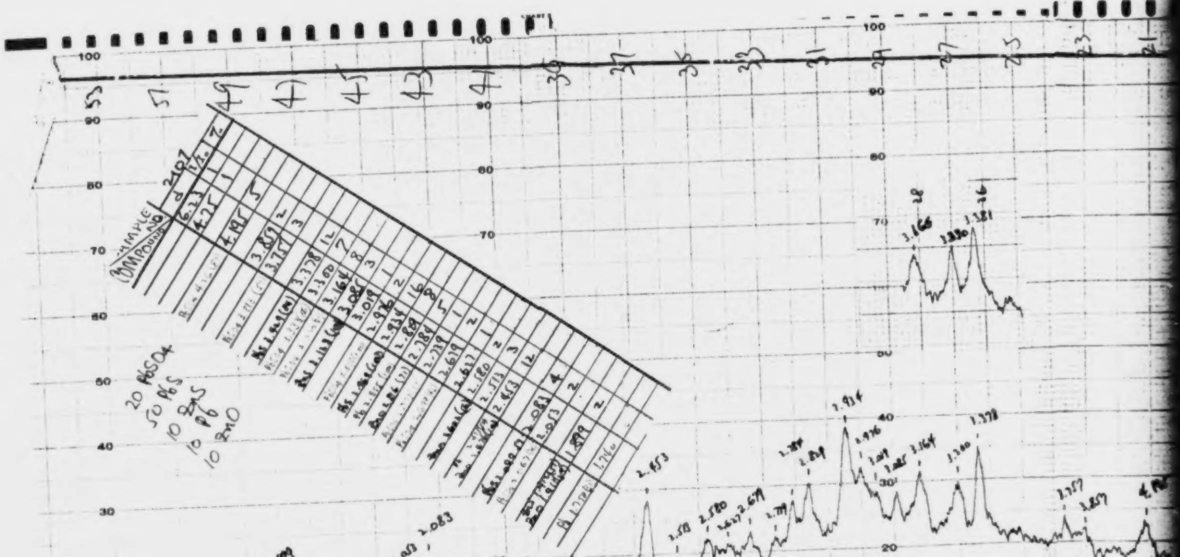
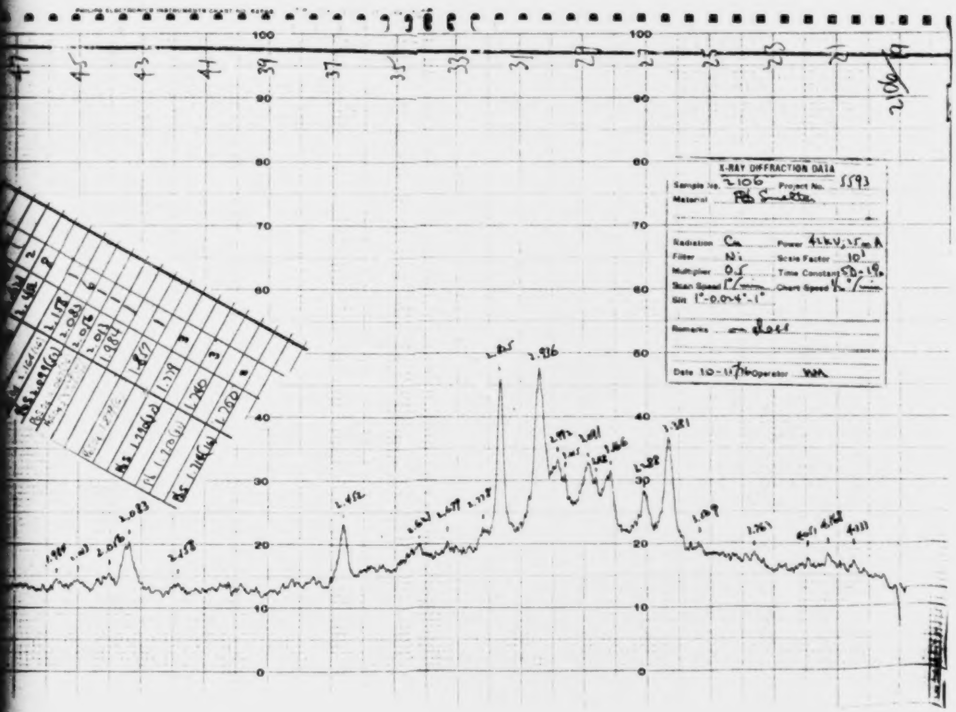


Figure G-28 - Run 28, Location 18, Filter 2107



X-RAY DIFFRACTION DATA

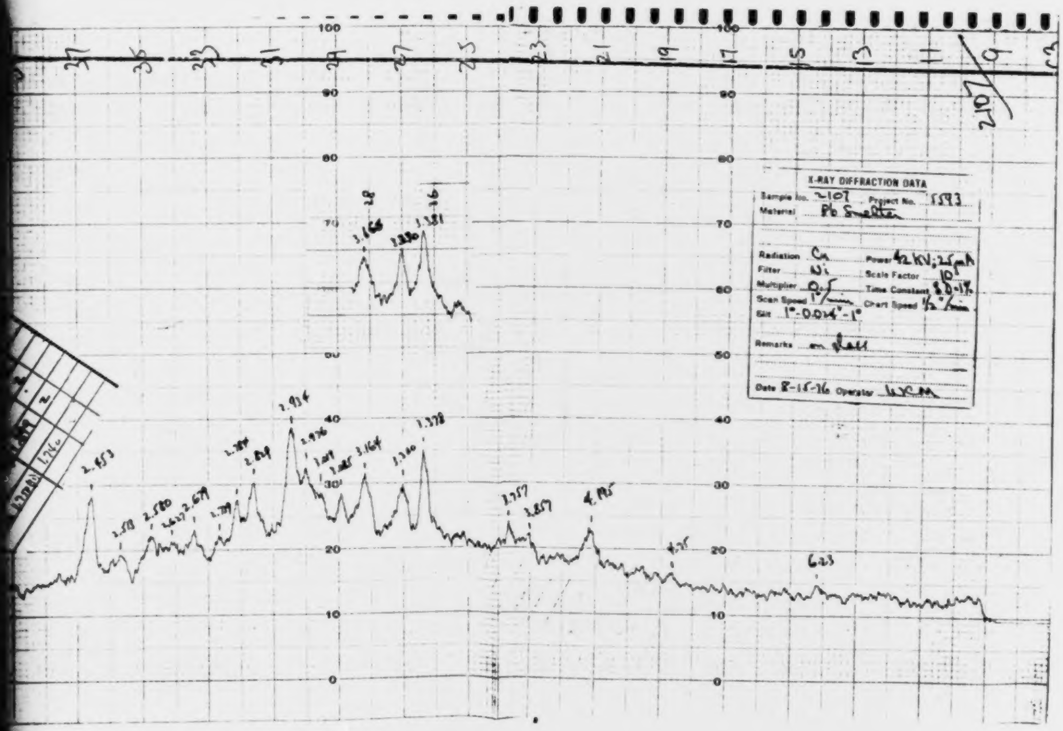
Sample No. 2106 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42kV; 25mA
Filter Ni Scale Factor 10^3
Multiplier 0.5 Time Constant SD-19
Scan Speed 1°/min Chart Speed ½°/min
Slit 1°-0.024°-1°

Remarks on glass

Date 10-11-76 Operator WM

e G-27 - Run 28, Location 17, Filter 2106



X-RAY DIFFRACTION DATA

Sample No. 2107 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10^3
Multiplier 0.5 Time Constant 8.0-17
Scan Speed 1°/min Chart Speed ½°/min
Slit 1°-0.024°-1°

Remarks on glass

Date 8-15-76 Operator WCM

e G-28 - Run 28, Location 18, Filter 2107

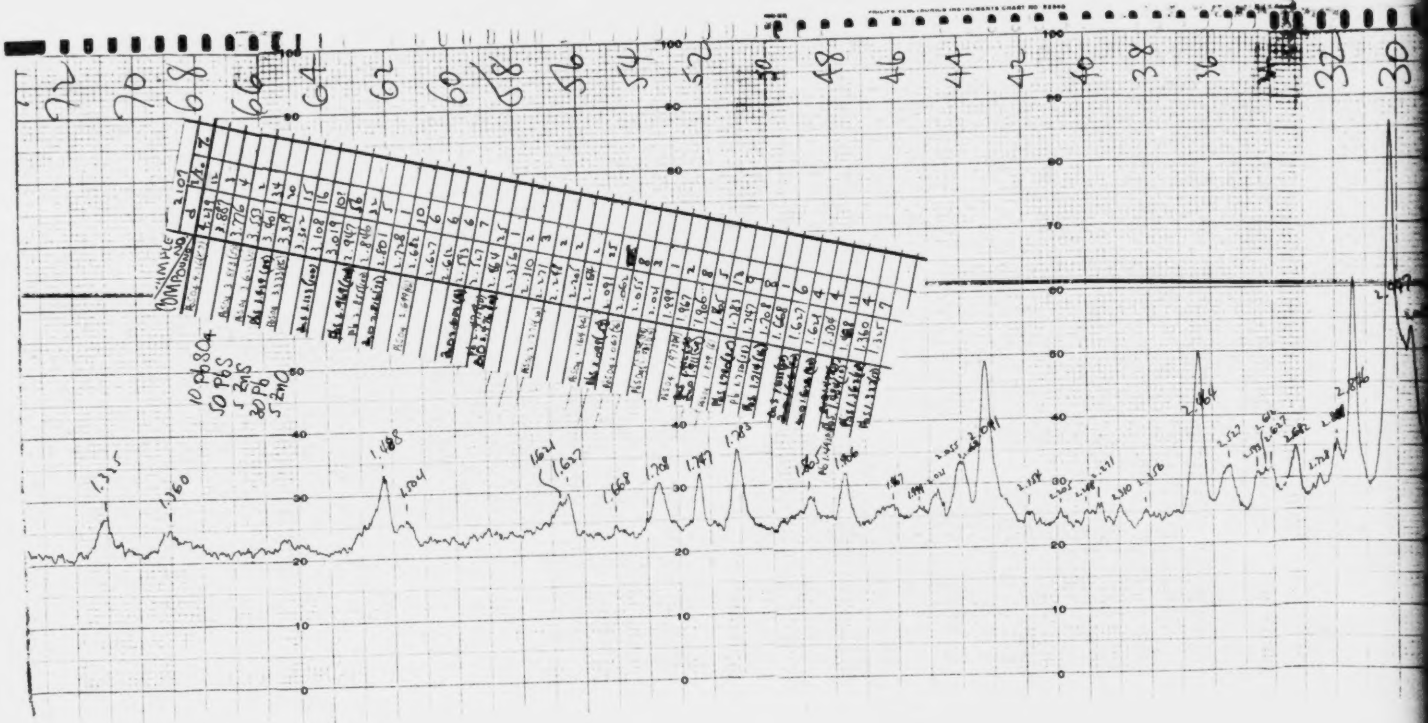
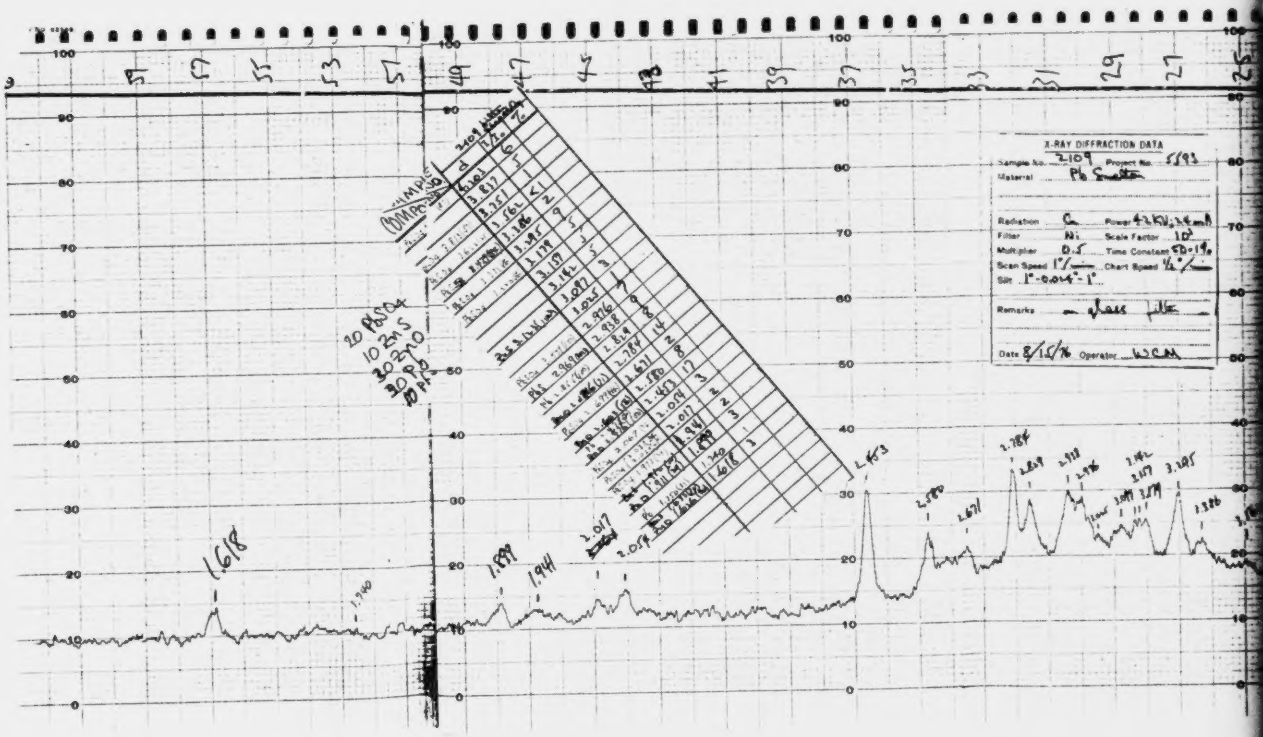


Figure G-29 - Run 28, Location 18, Filter 2107



X-RAY DIFFRACTION DATA

Sample No. 2109 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV; 24mA

Filter Ni Scale Factor 10²

Multiplier 0.5 Time Constant 5D-1%

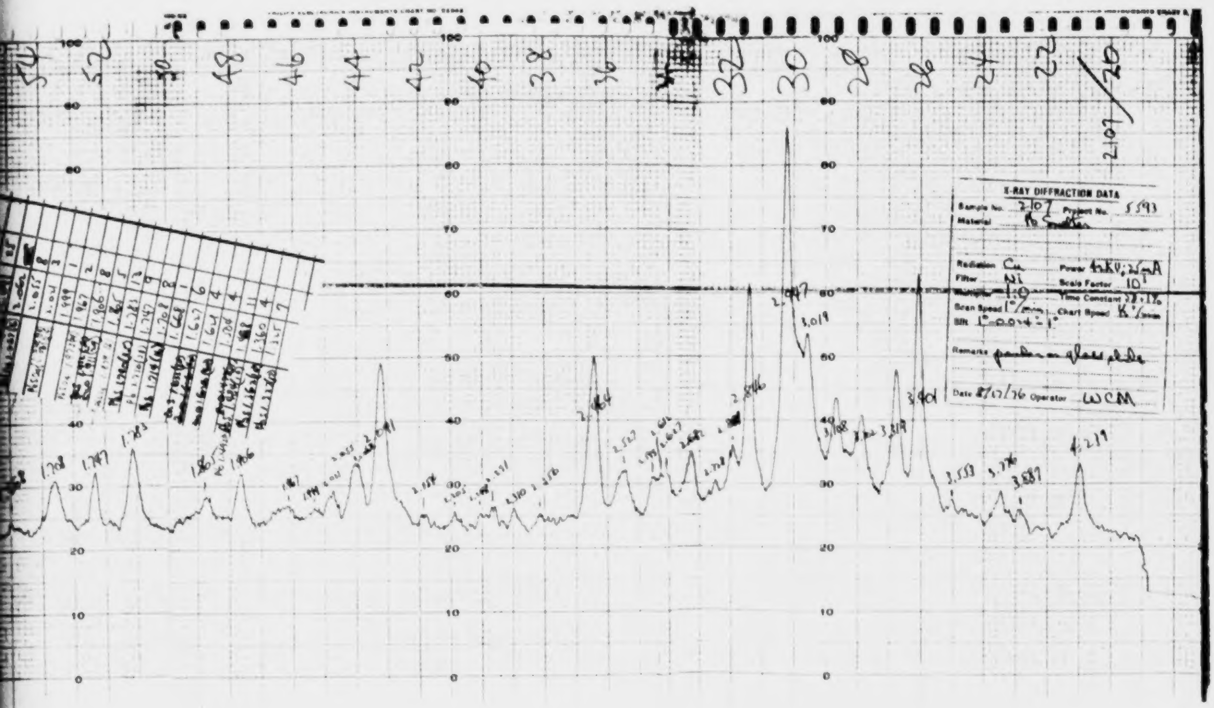
Scan Speed 1°/min Chart Speed ½°/min

Slit 1°-0.014°-1°

Remarks — glass filter —

Date 8/15/76 Operator WCM

Figure G-30 - Run 29, Location 18, Backup, Filter 2109



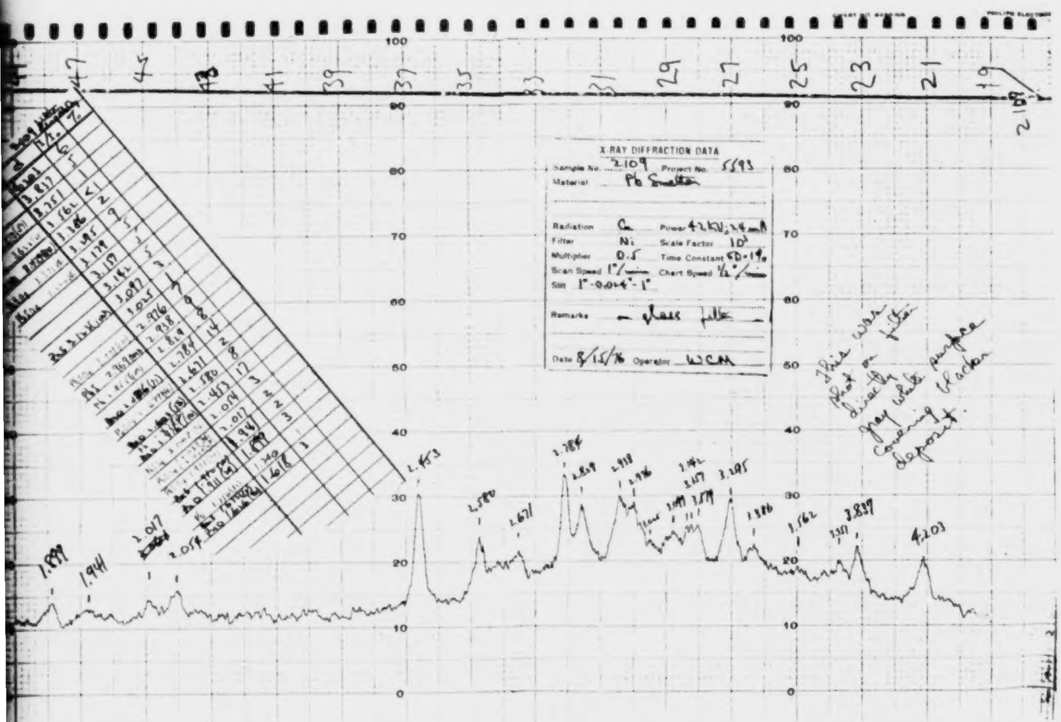
X-RAY DIFFRACTION DATA
Sample No. 2107 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10¹
Multiplier 1.0 Time Constant 3.2 + 1%
Scan Speed 1°/min Chart Speed ½°/min
Slit 1°-0.004°-1°

Remarks powder on glass slide

Date 8/17/76 Operator WCM

igure G-29 - Run 28, Location 18, Filter 2107



X-RAY DIFFRACTION DATA
Sample No. 2109 Project No. 5593
Material Pb Smelter

Radiation Cu Power 42KV; 24mA
Filter Ni Scale Factor 10¹
Multiplier 0.5 Time Constant 5D + 1%
Scan Speed 1°/min Chart Speed ½°/min
Slit 1°-0.004°-1°

Remarks on glass filter

Date 8/15/76 Operator WCM

This was
shot on filter
directly
gray white purple
covering blacker
deposit.

G-30 - Run 29, Location 18, Backup, Filter 2109

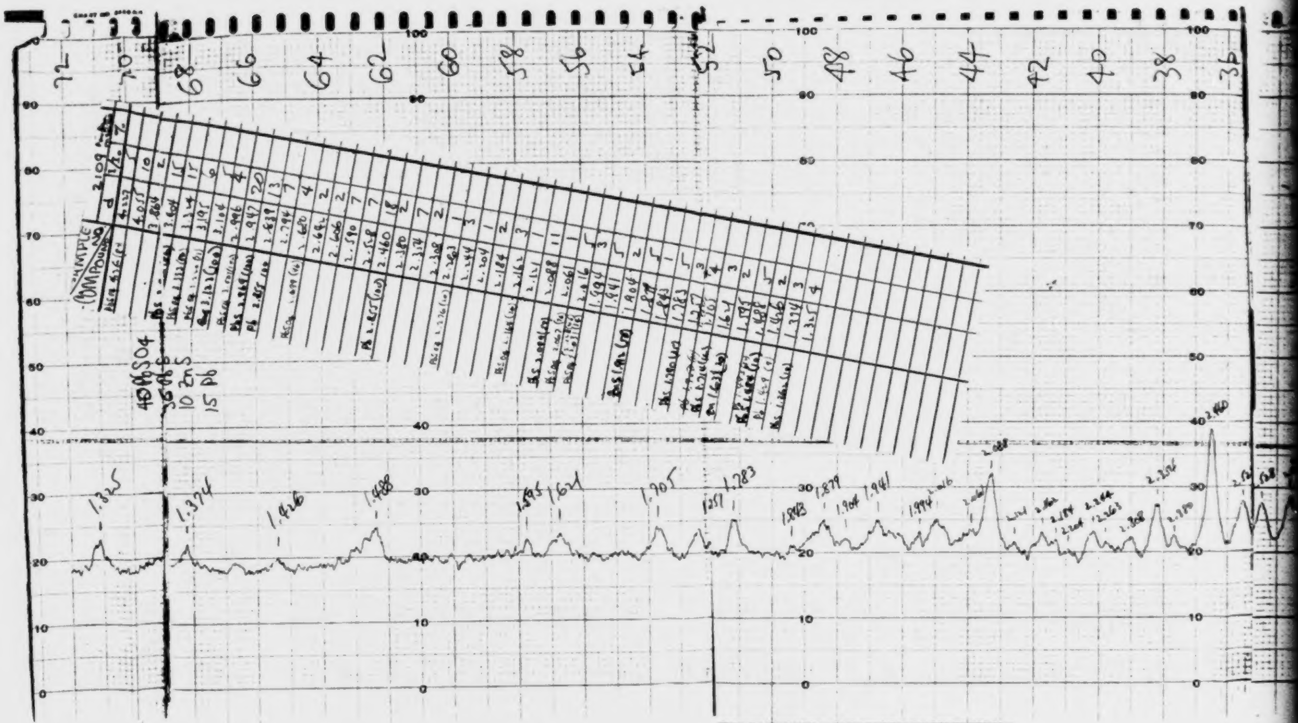


Figure G-31 - Run 29, Location 18, Backup, Filter 210

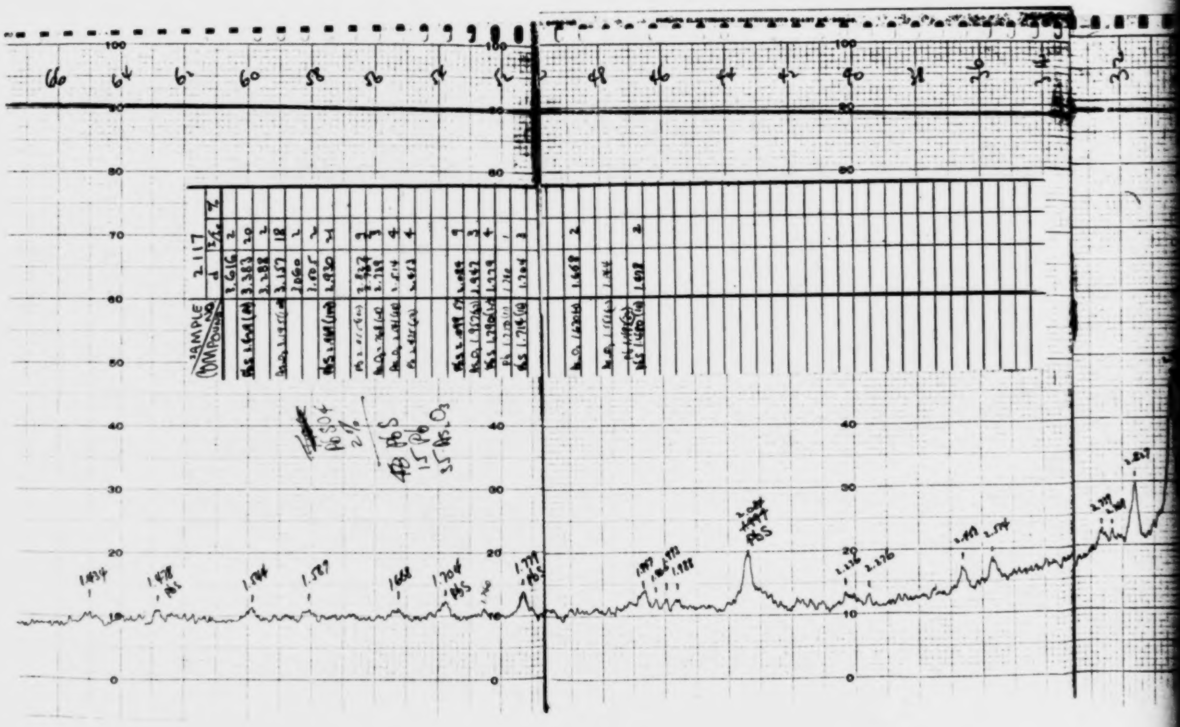
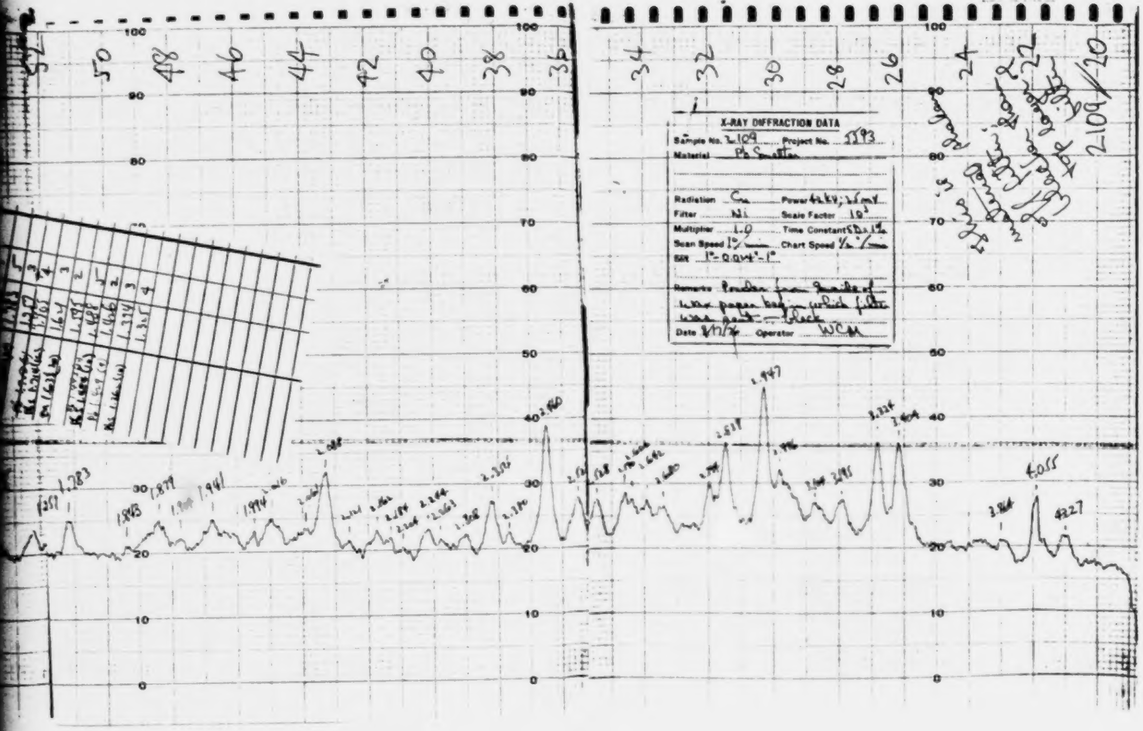
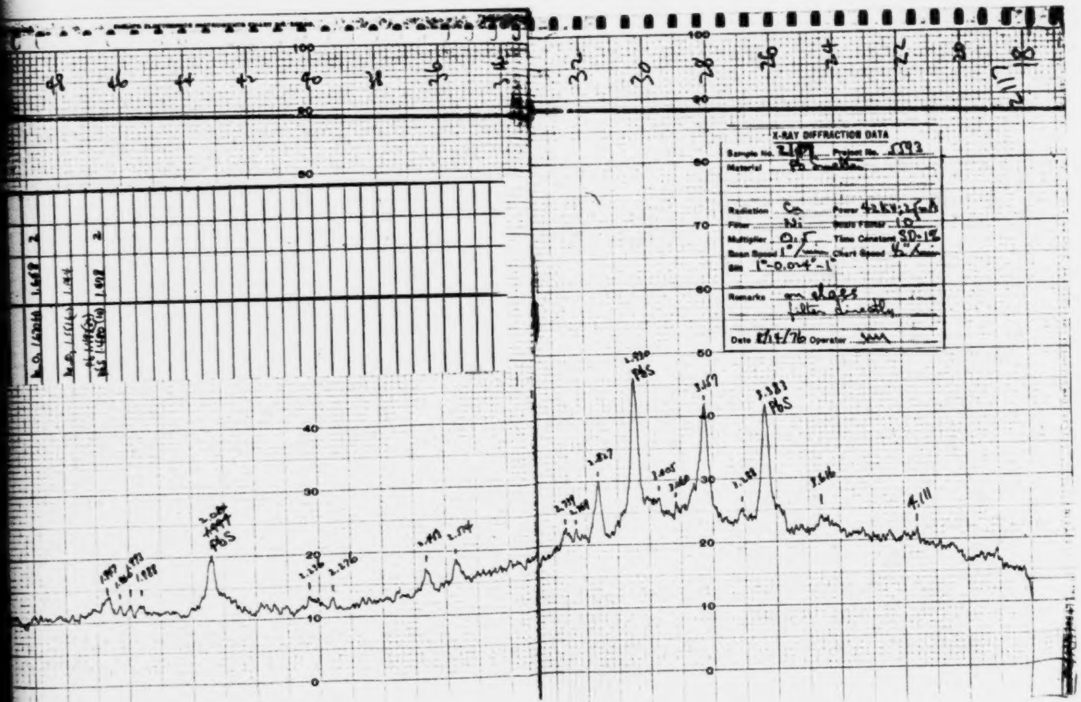


Figure G-32 - Run 31, Location 17, Backup, Filter 211



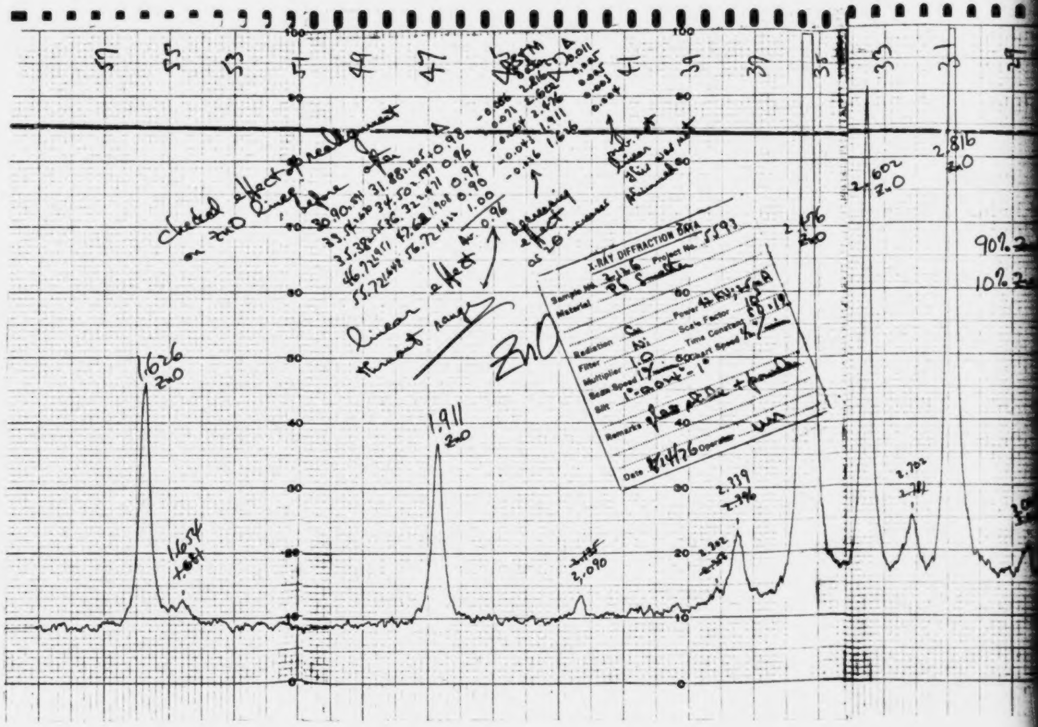
X-RAY DIFFRACTION DATA
Sample No. 2109 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42kV; 25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD-1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.04°-1°
Remarks Powder from inside of wax paper bag in which filter was sent — black
Date 8/17/76 Operator WCM

31 - Run 29, Location 18, Backup, Filter 2109



X-RAY DIFFRACTION DATA
Sample No. 2117 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42kV; 25mA
Filter Ni Scale Factor 10
Multiplier 0.5 Time Constant SD-1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.04°-1°
Remarks on glass filter directly
Date 8/14/76 Operator [illegible]

-32 - Run 31, Location 17, Backup, Filter 2117



X-RAY DIFFRACTION DATA

Sample No. 2126 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42 KV; 25 mA

Filter Ni Scale Factor 10

Multiplier 1.0 Time Constant [illegible]

Scan Speed 1°/min Chart Speed [illegible]

Slit 1°-0.004"-1°

Remarks [illegible]

Date 8/14/76 Operator [illegible]

Figure G-33 - Run 33, Location 20, Backup, Filter

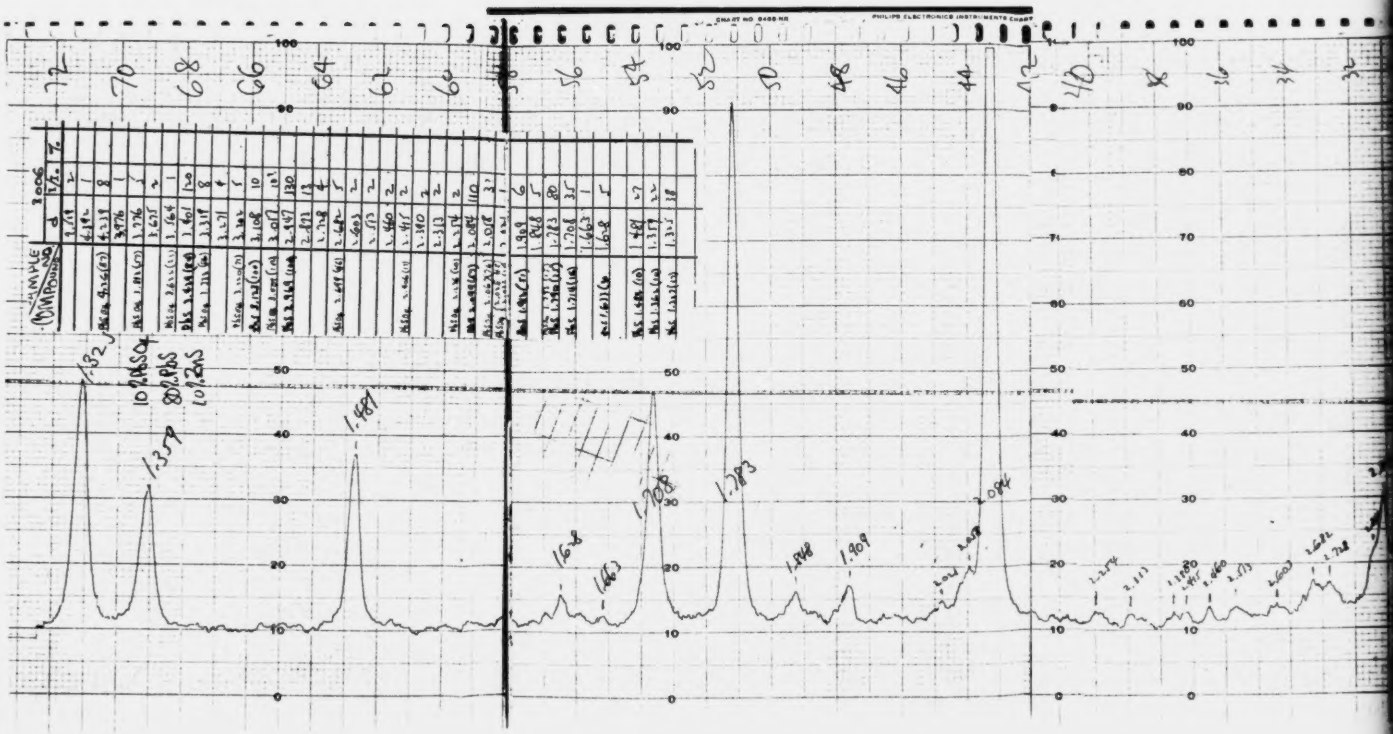
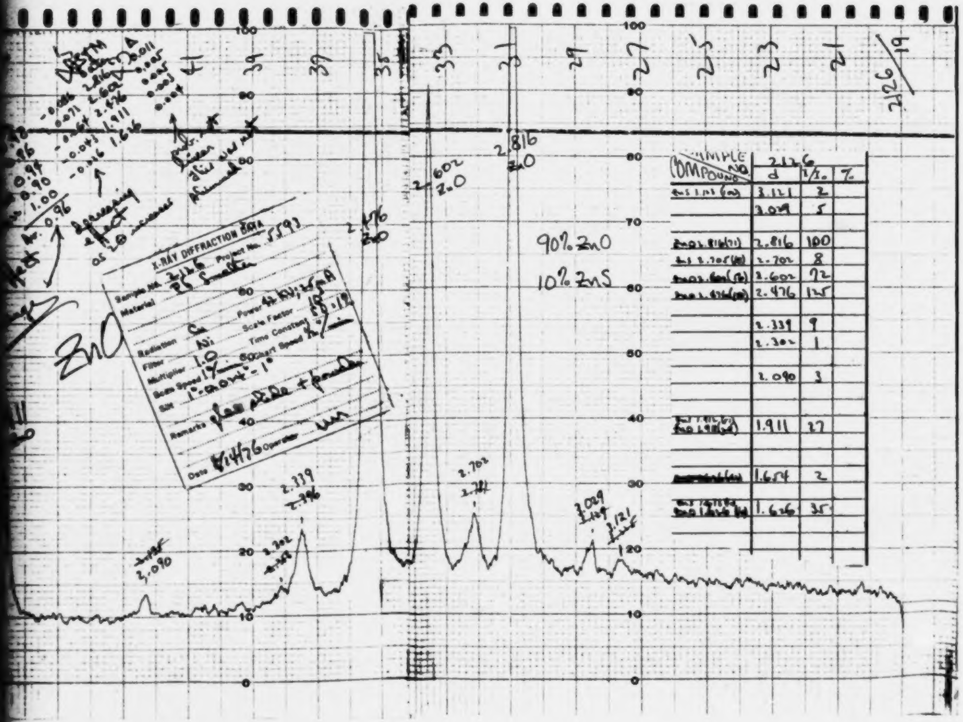


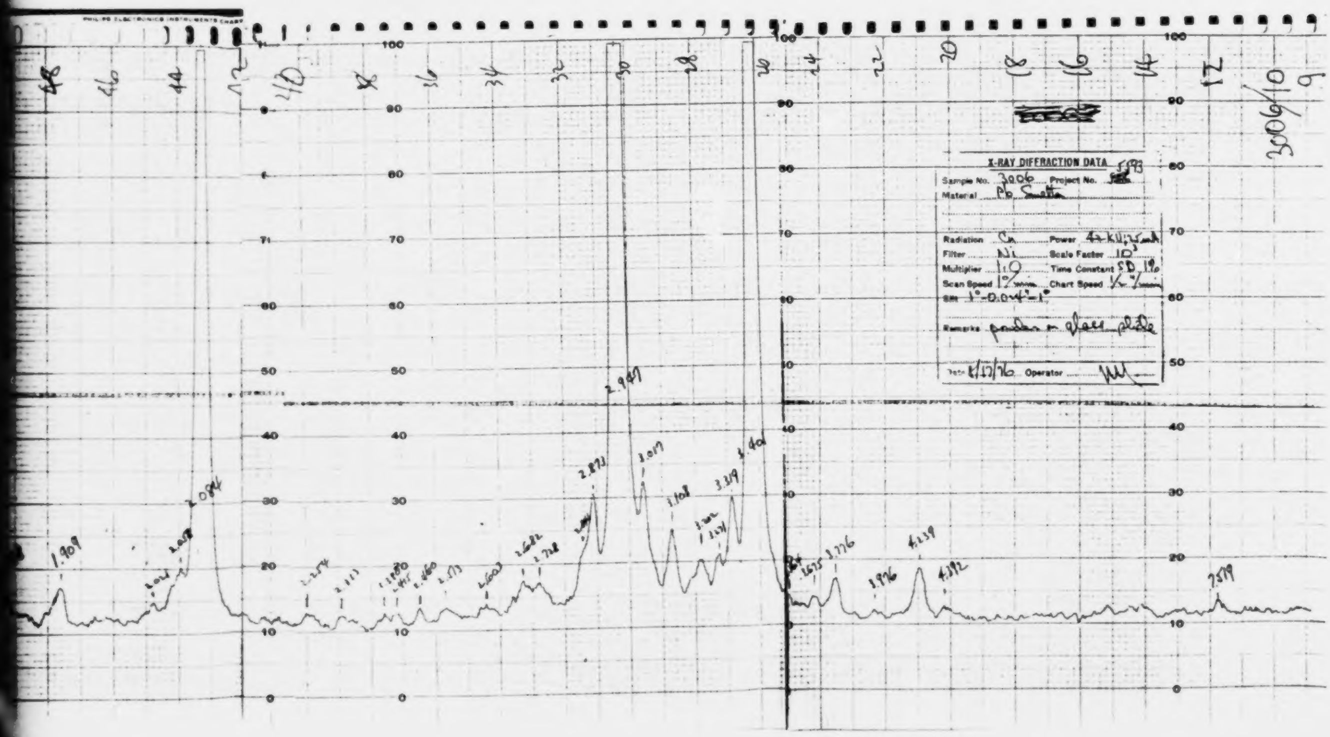
Figure G-34 - Run 2, Location 1, Filter 3006



X-RAY DIFFRACTION DATA
Sample No. 2126 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42 kV; 25 mA
Scale Factor 10
Filter Ni Time Constant .12
Multiplier 1.0 Chart Speed ½"/min
Scan Speed 1°/min
Slit 1°-0.004°-1°
Remarks glass slide + powder
Date 8/14/76 Operator

COMPOUND \ SAMPLE NO.	2126 d	I/I₀	%
[illegible]	3.121	2	
	3.049	5	
[illegible]	2.816	100	
[illegible]	2.702	8	
[illegible]	2.602	72	
[illegible]	2.476	125	
	2.339	9	
	2.302	1	
	2.090	3	
[illegible]	1.911	27	
[illegible]	1.654	2	
[illegible]	1.626	35	

-33 - Run 33, Location 20, Backup, Filter 2126



X-RAY DIFFRACTION DATA 5593
Sample No. 3006 Project No.
Material Pb Smelter
Radiation Cu Power 42 kV; 25 mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD 1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.004°-1°
Remarks powder on glass plate
Date 8/17/76 Operator

re G-34 - Run 2, Location 1, Filter 3006

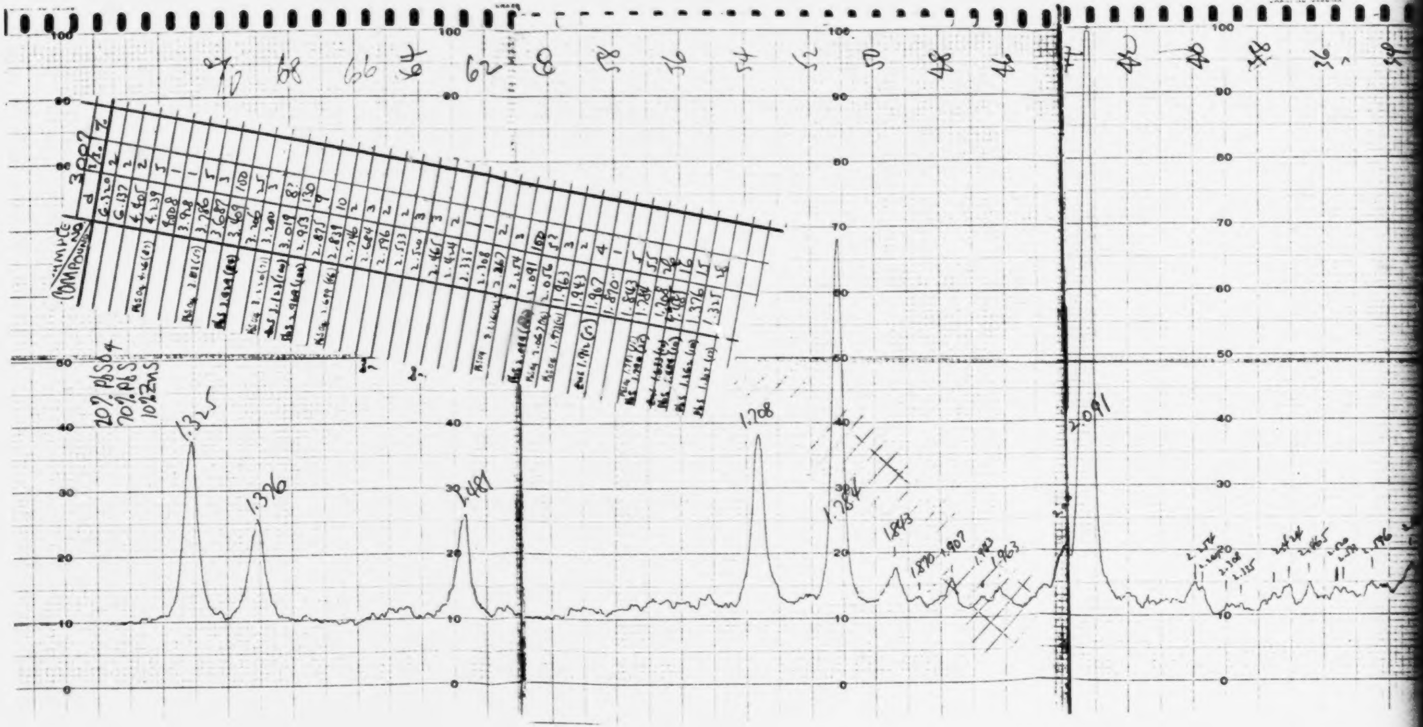


Figure G-35 - Run 2, Location 1, Filter 3007

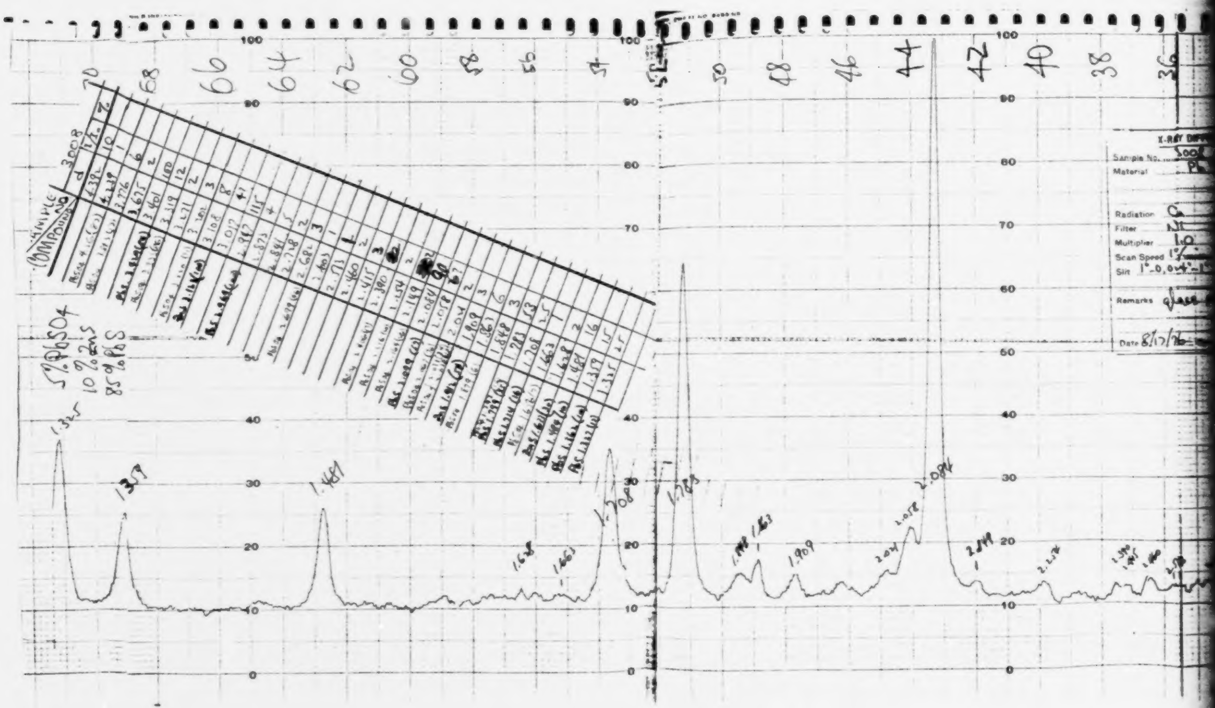
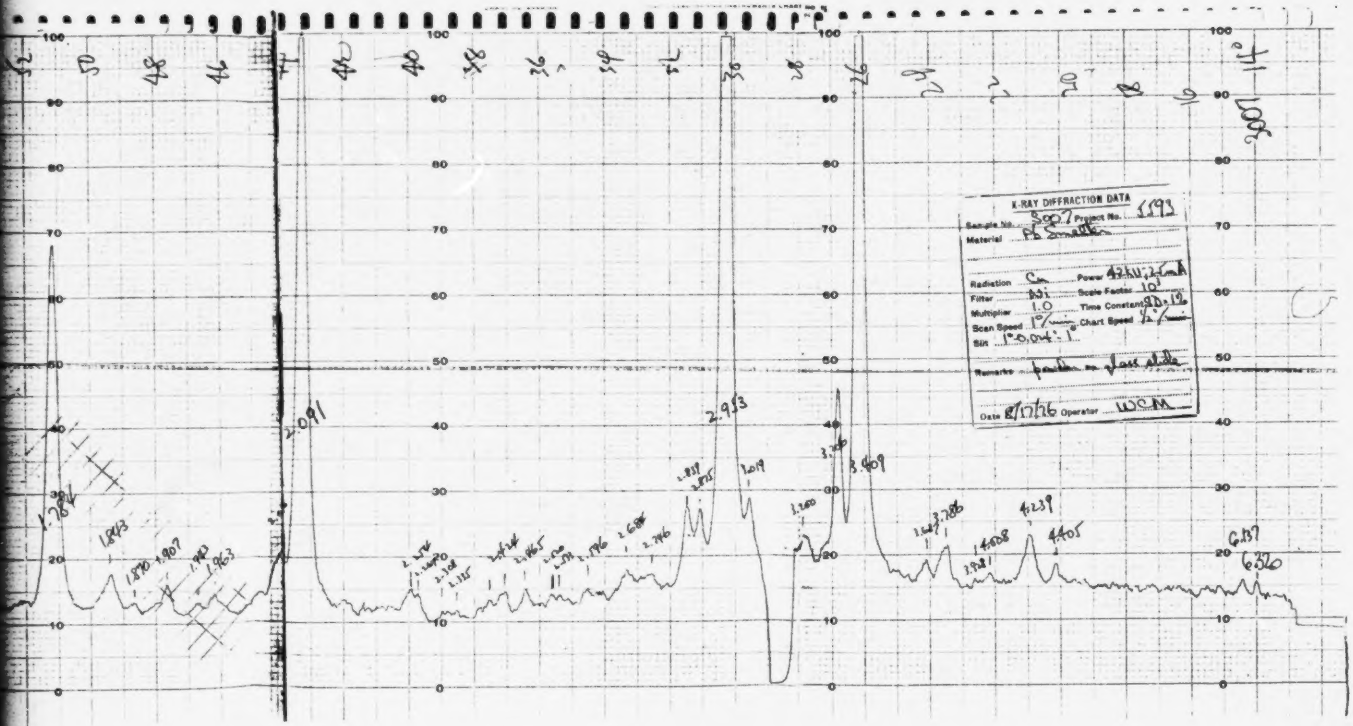


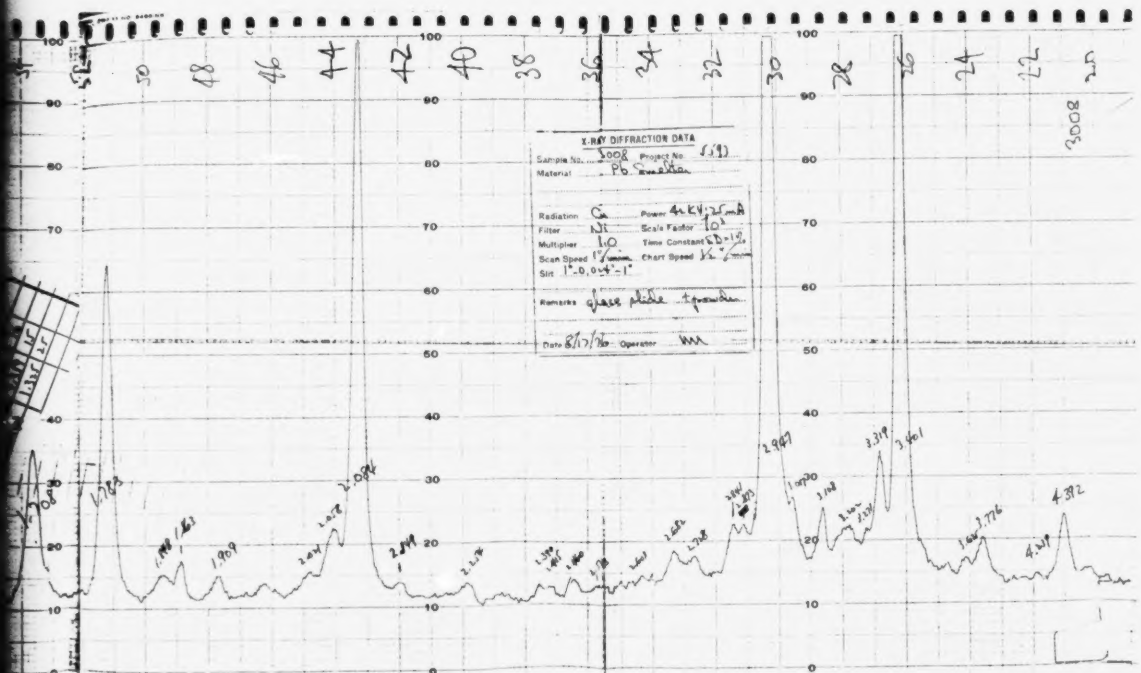
Figure G-36 - Run 2, Location 1, Filter 3008



X-RAY DIFFRACTION DATA

Sample No. 3007 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42kV;25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD=1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.04°-1°
Remarks powder on glass slide
Date 8/17/76 Operator WCM

ure G-35 - Run 2, Location 1, Filter 3007



X-RAY DIFFRACTION DATA

Sample No. 3008 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42kV;25mA
Filter Ni Scale Factor 10³
Multiplier 1.0 Time Constant SD=1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.04°-1°
Remarks glass slide + powder
Date 8/17/76 Operator WM

ure G-36 - Run 2, Location 1, Filter 3008

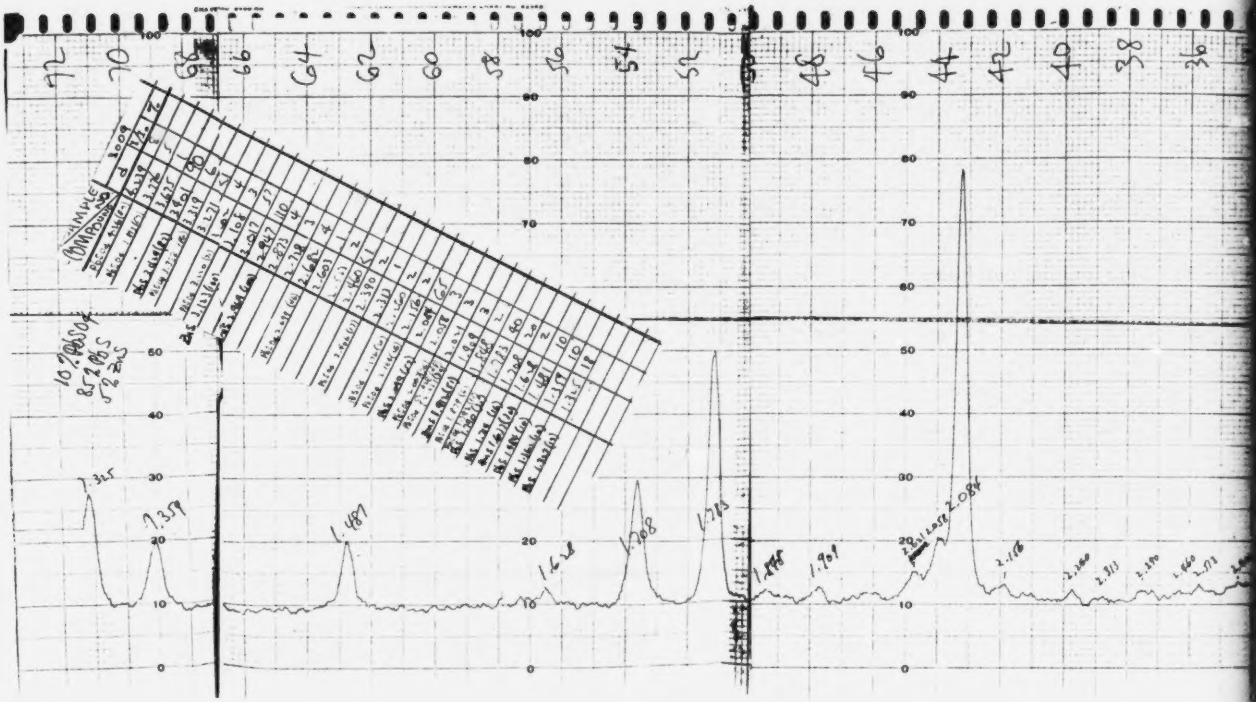


Figure G-37 - Run 2, Location 1, Filter 3009

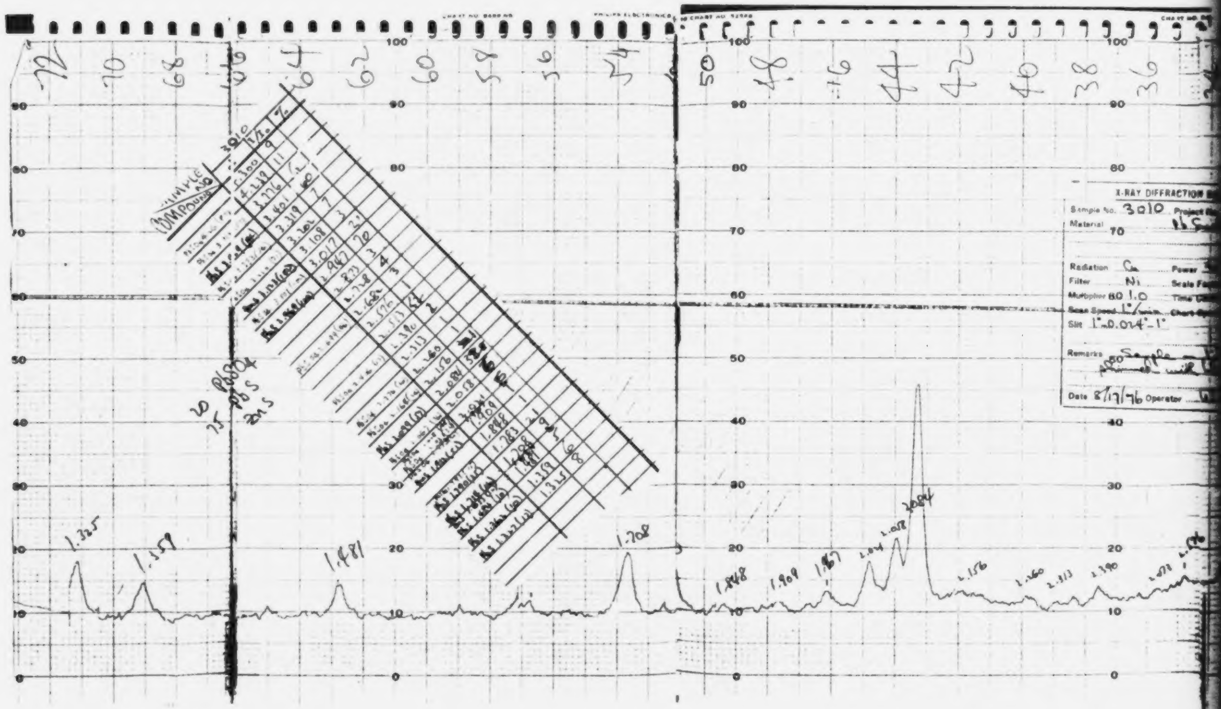
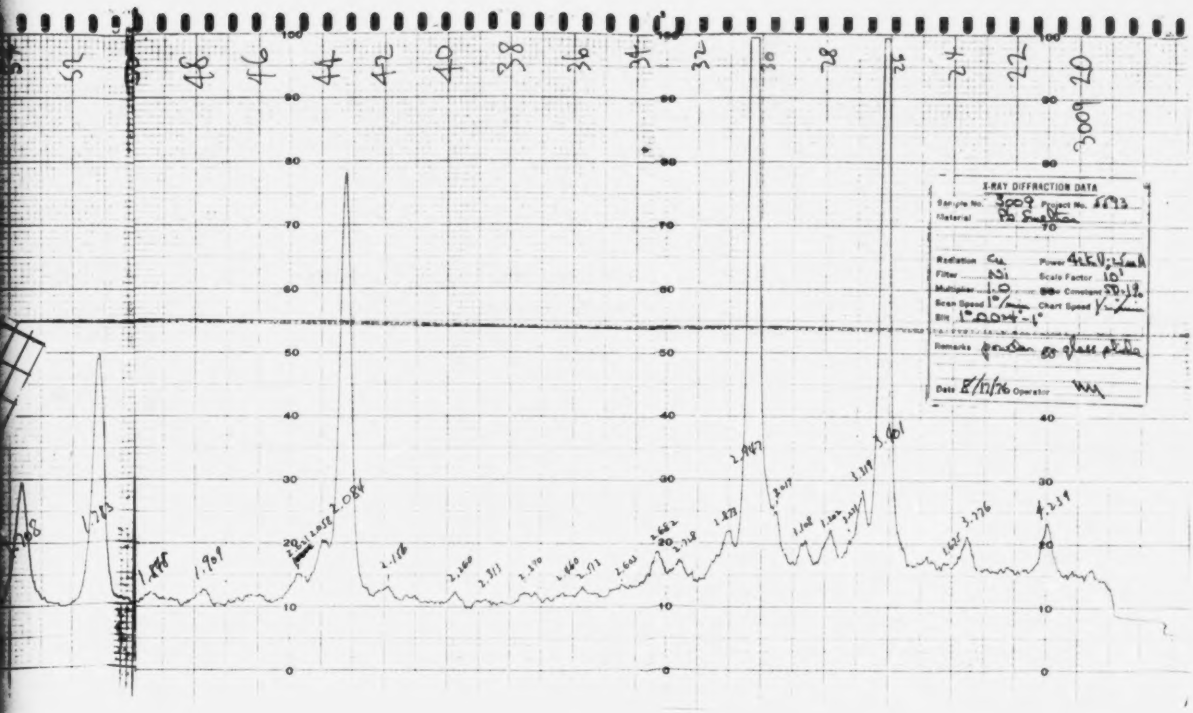


Figure G-38 - Run 2, Location 1, Filter 3010



X-RAY DIFFRACTION DATA

Sample No. 3009 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42kV; 26mA

Filter Ni Scale Factor 10'

Multiplier 1.0 Time Constant 50-1%

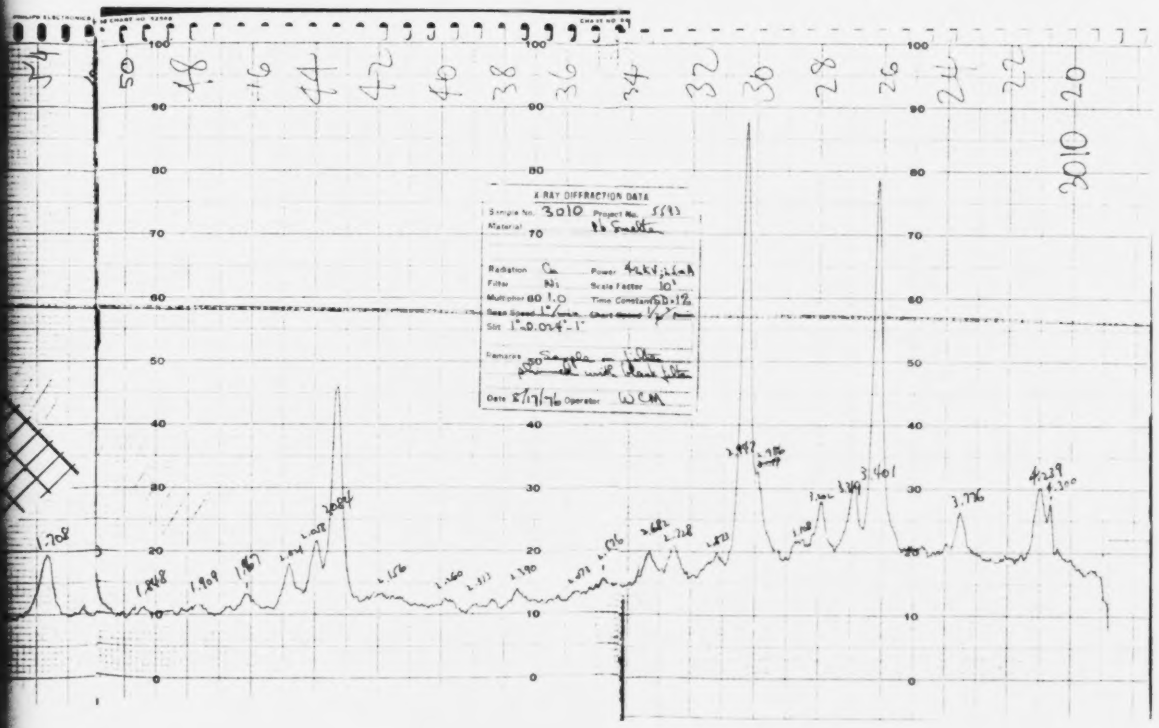
Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.024°-1°

Remarks powder on glass slide

Date 8/17/76 Operator WCM

igure G-37 - Run 2, Location 1, Filter 3009



X-RAY DIFFRACTION DATA

Sample No. 3010 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42kV; 26mA

Filter Ni Scale Factor 10'

Multiplier 1.0 Time Constant 50-1%

Scan Speed 1°/min ~~Chart Speed~~ 1/2"/min

Slit 1°-0.024°-1°

Remarks Sample on filter ~~[illegible]~~ with blank filter

Date 8/17/76 Operator WCM

gure G-38 - Run 2, Location 1, Filter 3010

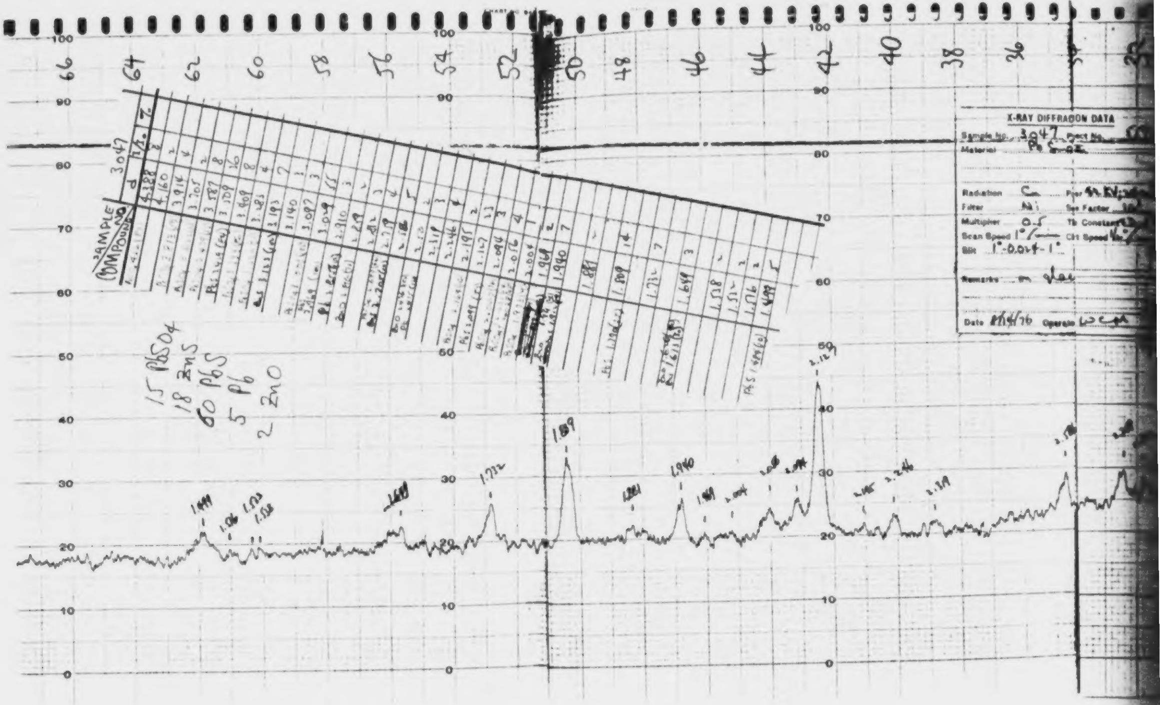


Figure G-39 - Run 21, Location 13, Filter 3047

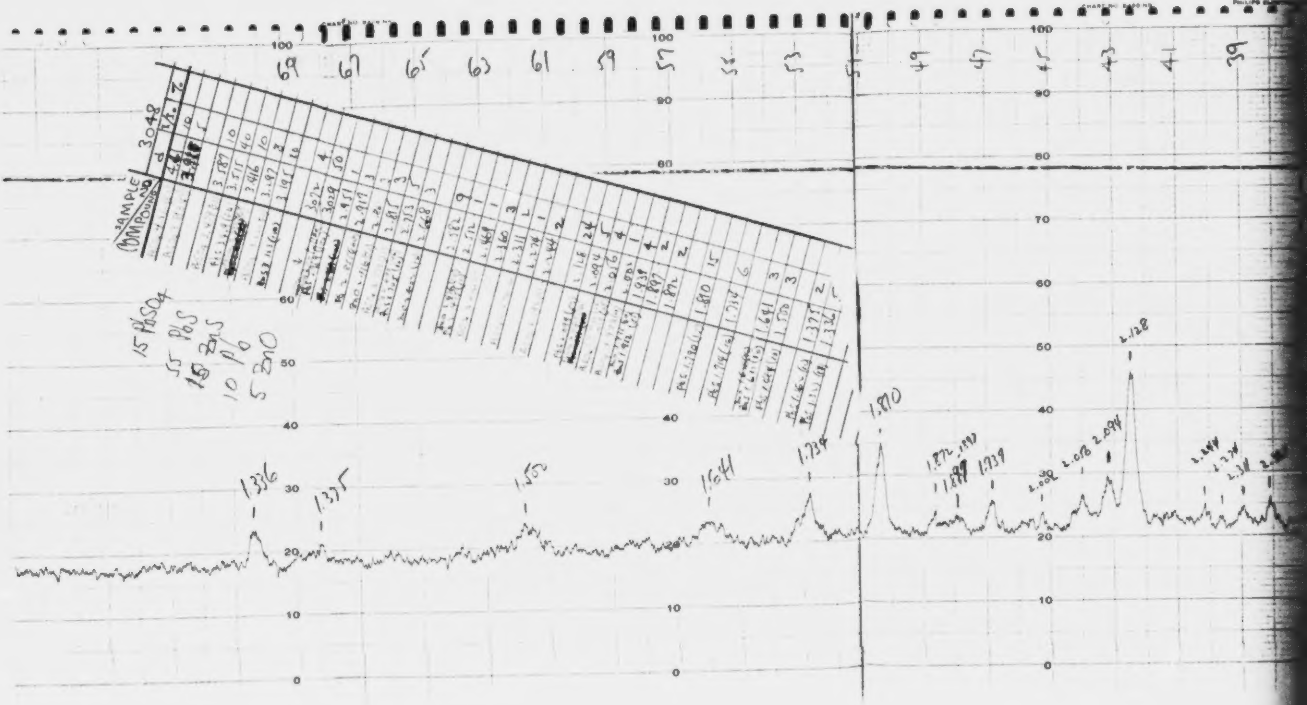
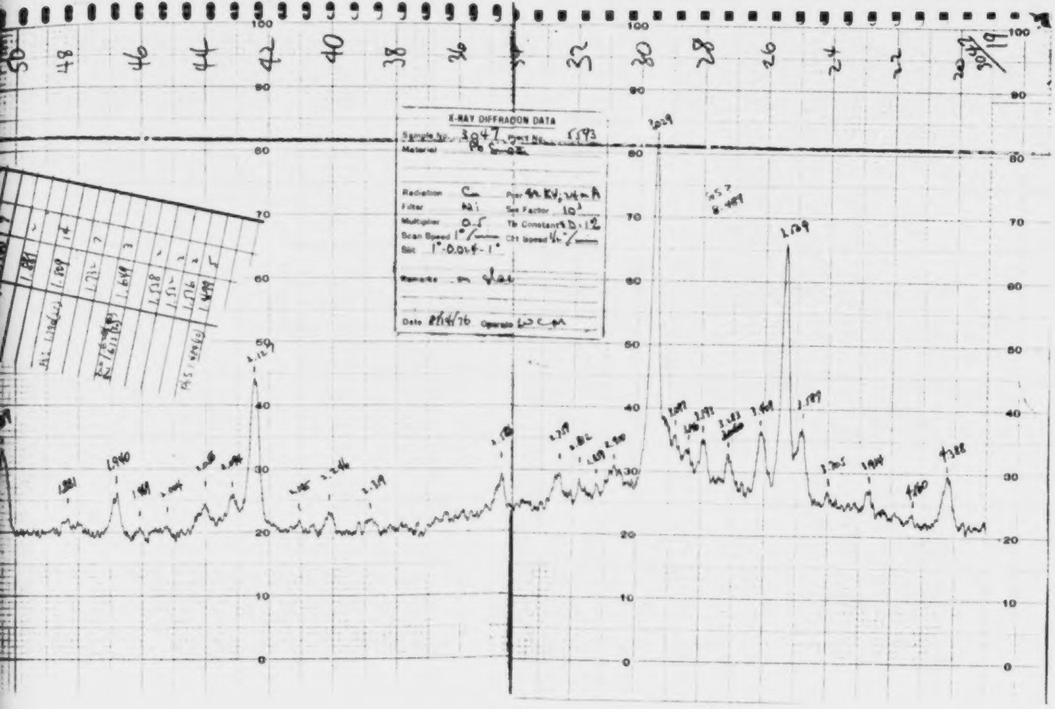


Figure G-40 - Run 21, Location 13, Filter 304



X-RAY DIFFRACTION DATA

Sample No. 3047 Project No. 5593

Material Pb S-02

Radiation Cu Power 42 KV; 24 mA

Filter Ni Sc Factor 10³

Multiplier 0.5 Tb Constant 0.12

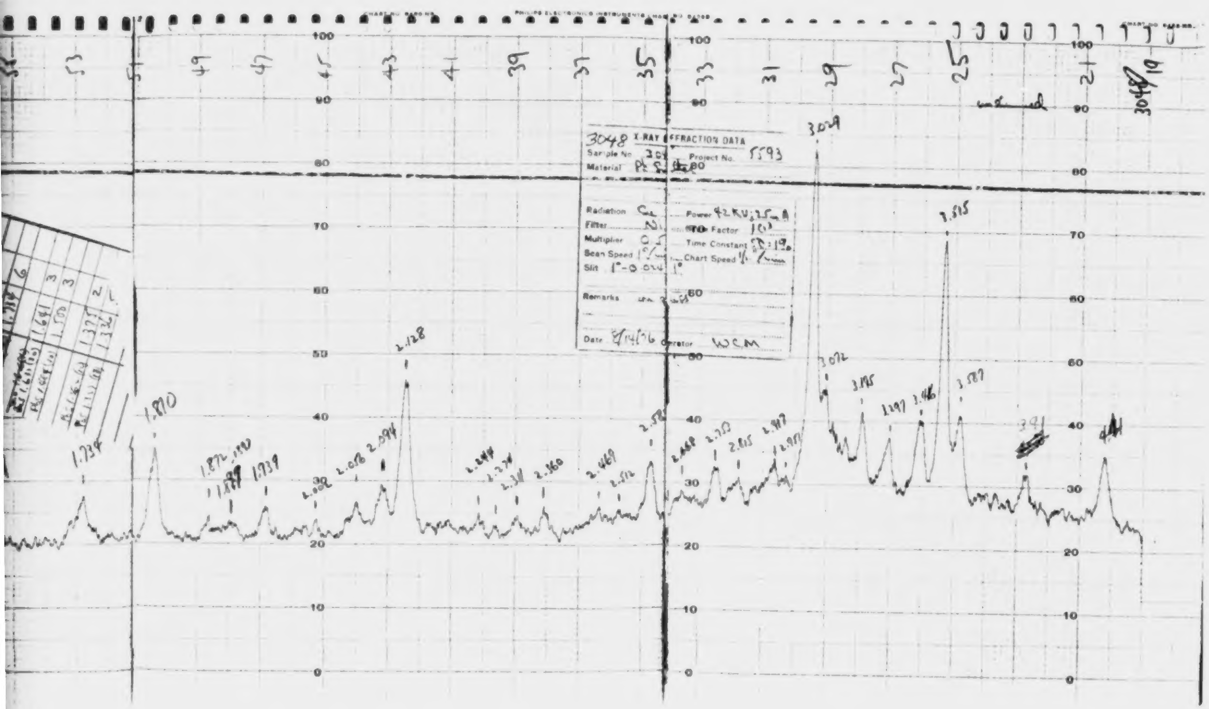
Scan Speed 1°/ Ch Speed 1/2"/

Slit 1°-0.024-1°

Remarks

Date 8/14/76 Operator WCM

e G-39 - Run 21, Location 13, Filter 3047



3048 X-RAY DIFFRACTION DATA

Sample No. 304 Project No. 5593

Material Pb S

Radiation Cu Power 42 KV; 25 mA

Filter Ni Factor 10³

Multiplier 0.5 Time Constant

Scan Speed 1°/ Chart Speed 1/2"/

Slit 1°-0.024 1°

Remarks

Date 8/14/76 Operator WCM

G-40 - Run 21, Location 13, Filter 3048

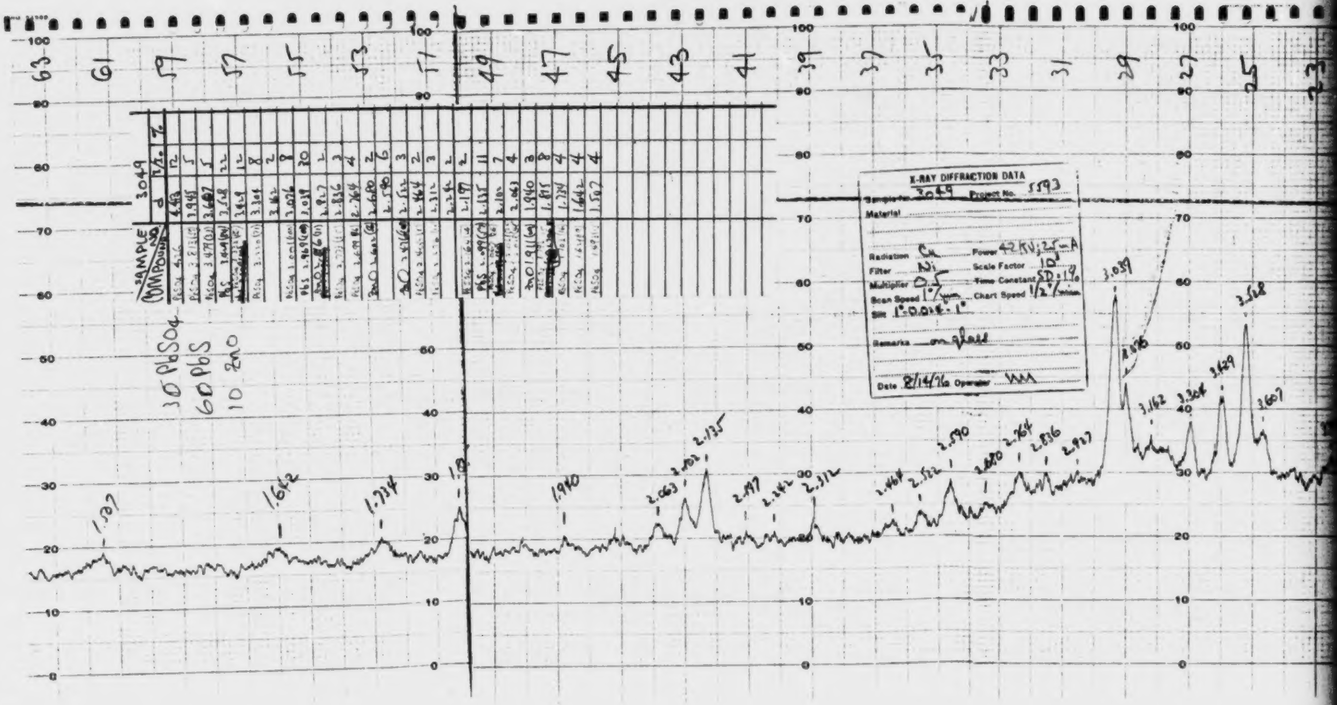


Figure G-41 - Run 21, Location 13, Filter 3049

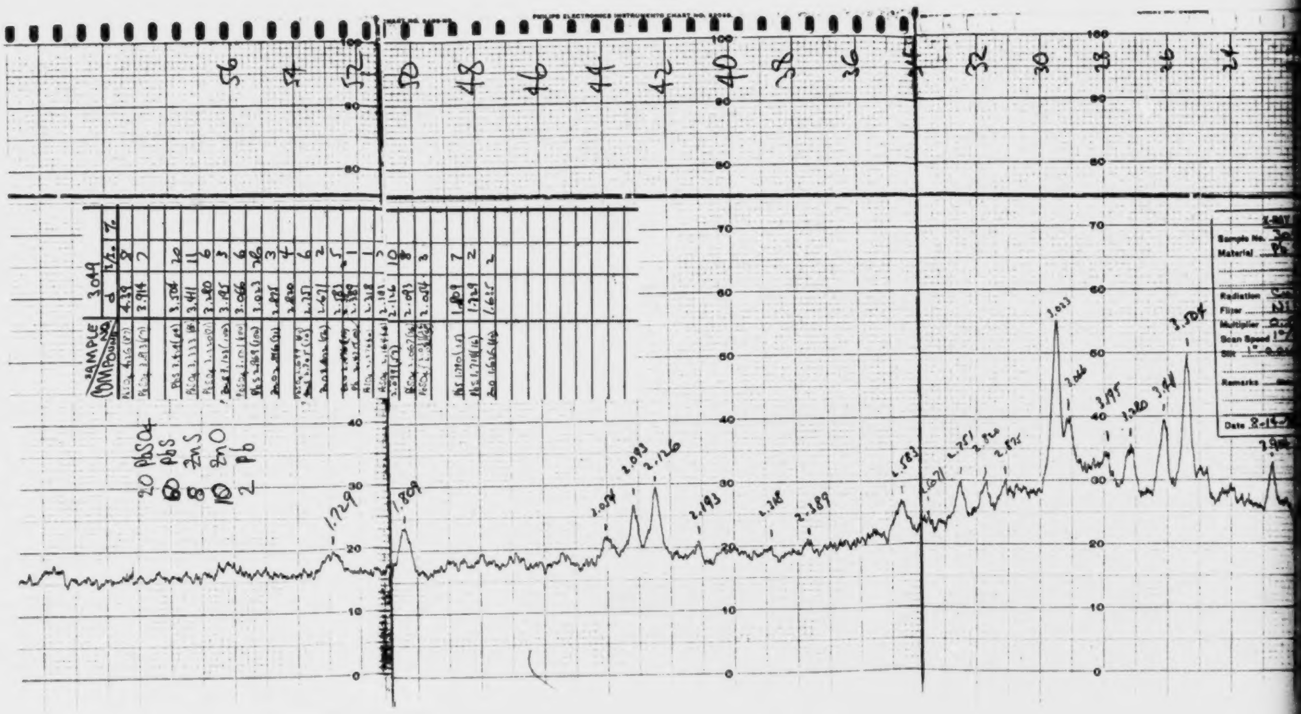
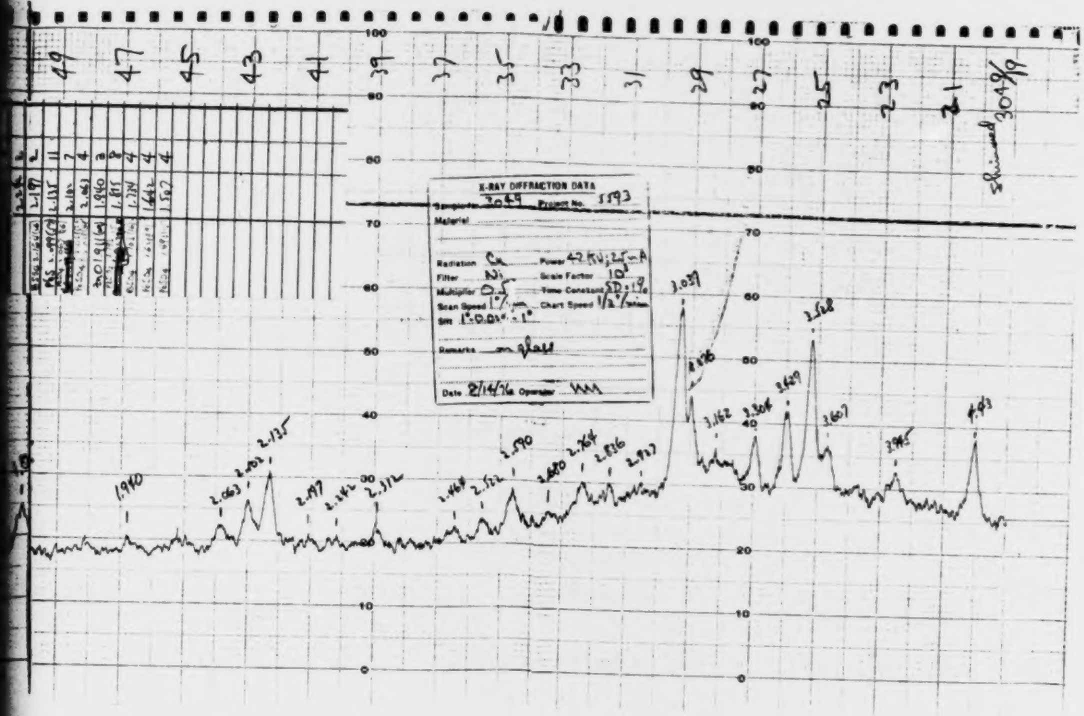
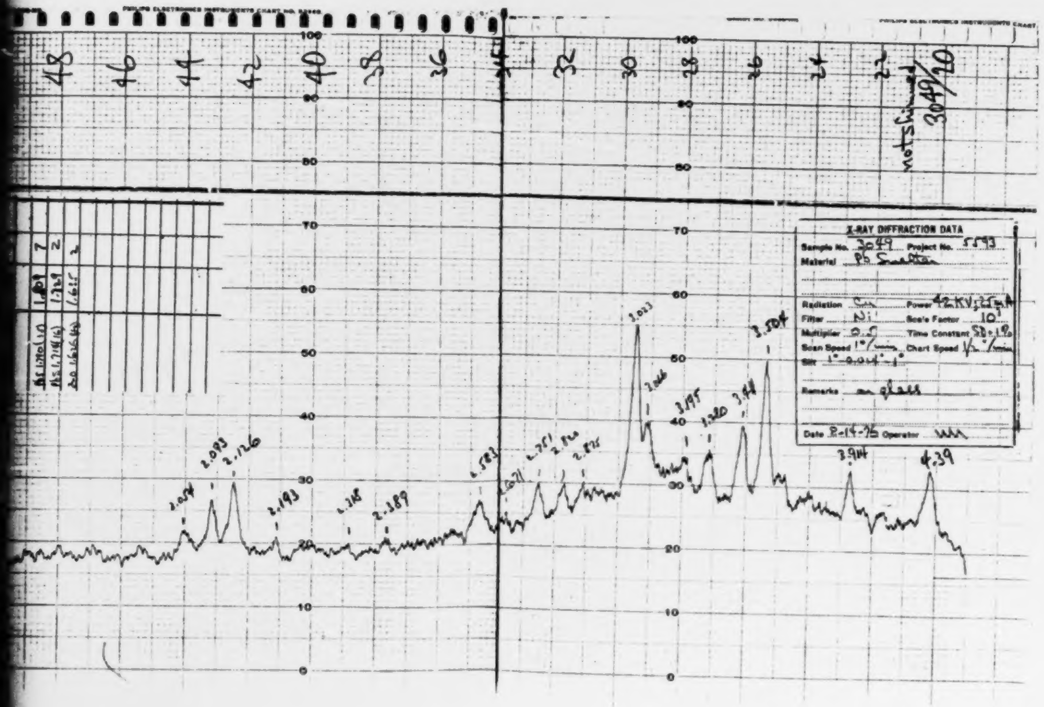


Figure G-42 - Run 21, Location 13, Filter 3049



igure G-41 - Run 21, Location 13, Filter 3049



gure G-42 - Run 21, Location 13, Filter 3049

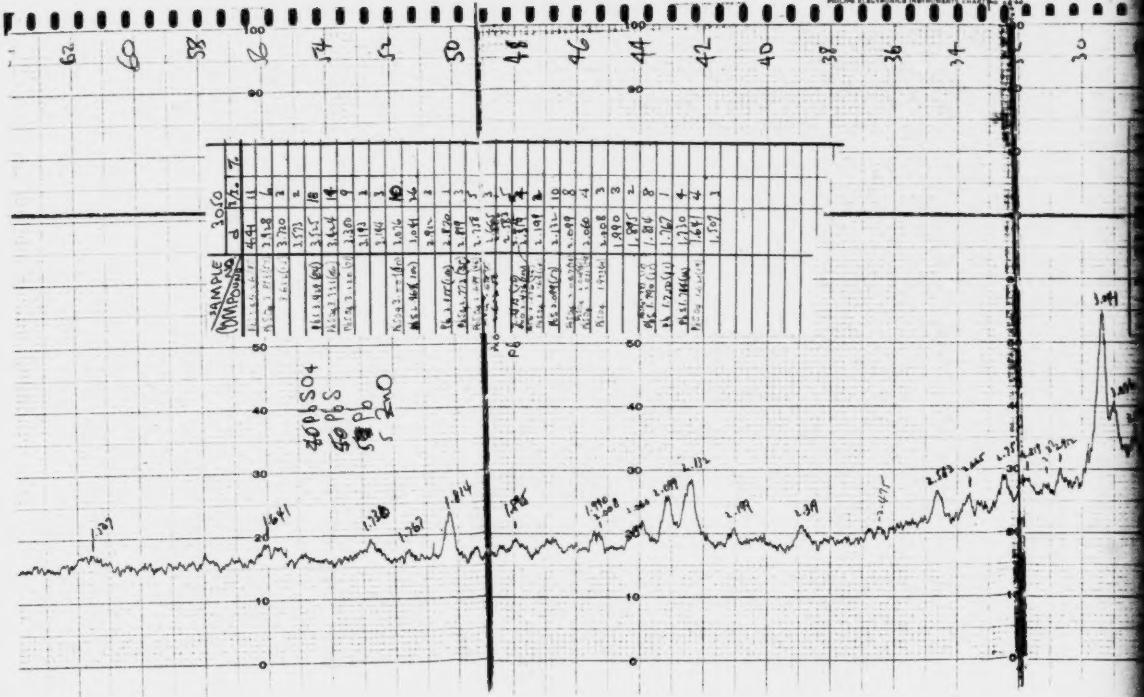


Figure G-43 - Run 21, Location 13, Filter 3050

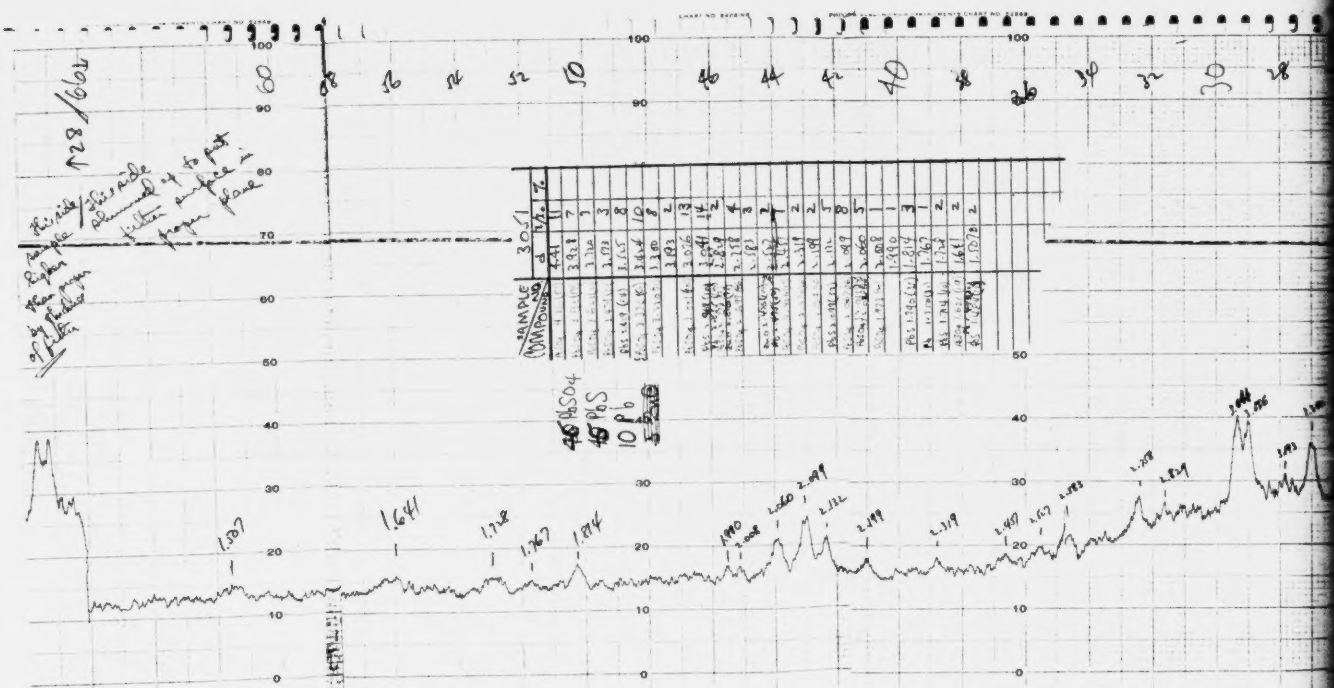
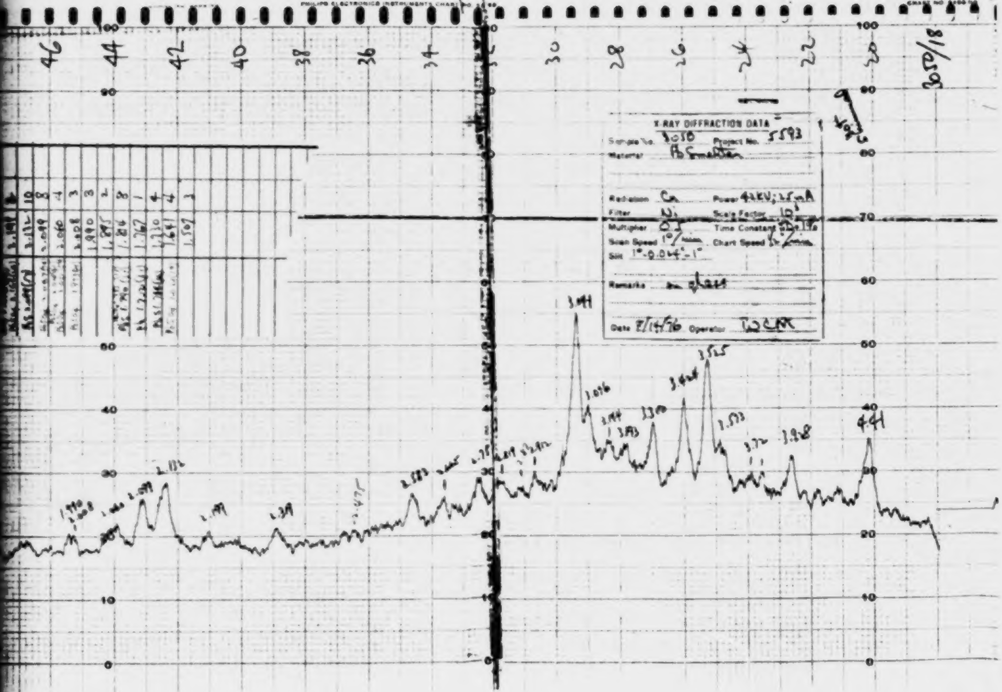


Figure G-44 - Run 21, Location 13, Filter 3051



X-RAY DIFFRACTION DATA

Sample No. 3050 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV; 25mA

Filter Ni Scale Factor 10^3

Multiplier 0.5 Time Constant [illegible]

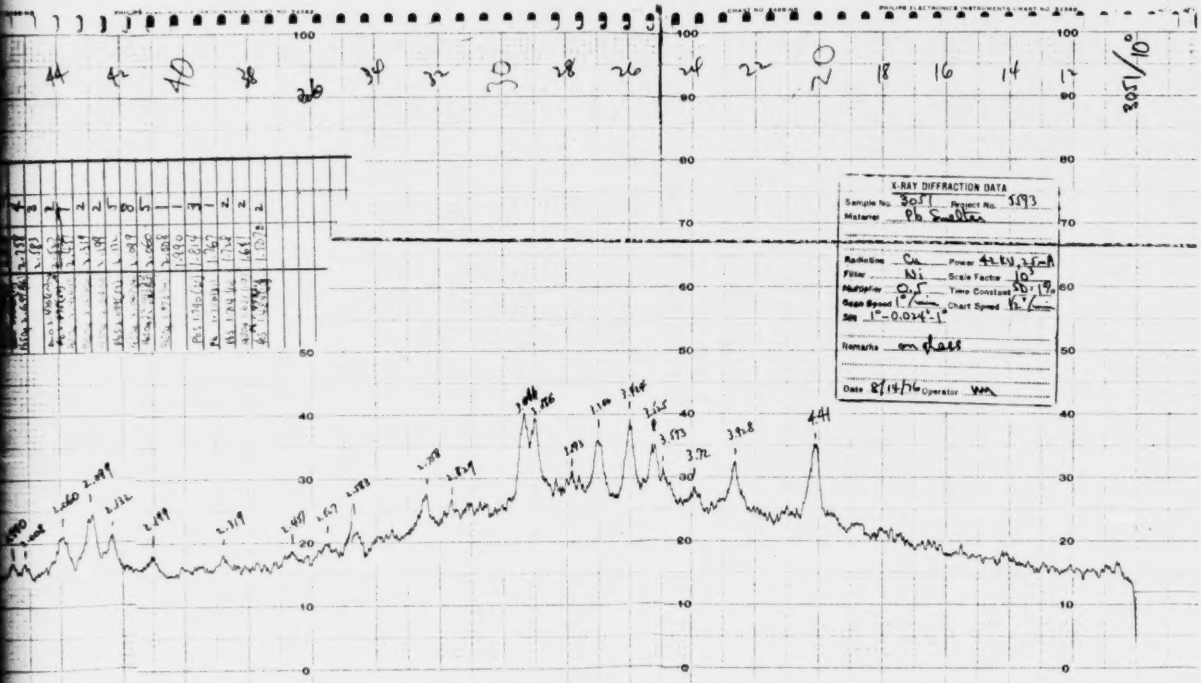
Scan Speed 1°/min Chart Speed [illegible]/min

Slit 1°-0.04°-1°

Remarks on glass

Date 8/14/76 Operator [illegible]

G-43 - Run 21, Location 13, Filter 3050



X-RAY DIFFRACTION DATA

Sample No. 3051 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV, 25mA

Filter Ni Scale Factor 10^3

Multiplier 0.5 Time Constant 50 : 1%

Scan Speed 1°/min Chart Speed ½"/min

Slit 1°-0.024°-1°

Remarks on glass

Date 8/14/76 Operator [illegible]

G-44 - Run 21, Location 13, Filter 3051

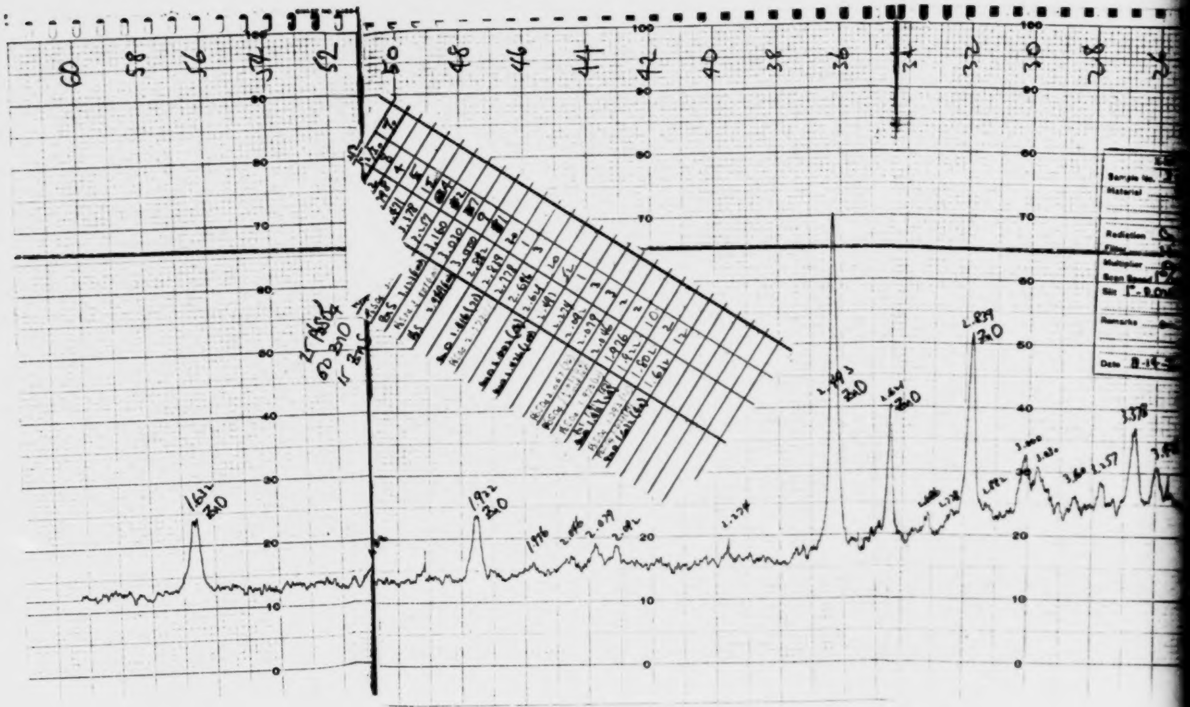


Figure G-45 - Run 26, Location 23, Filter 3052

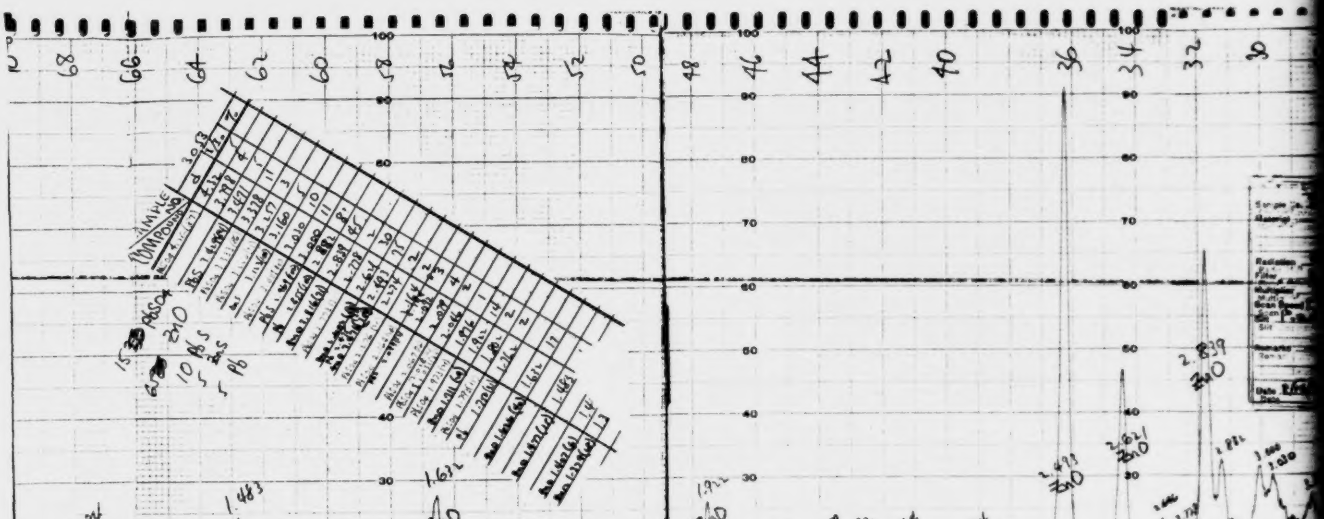
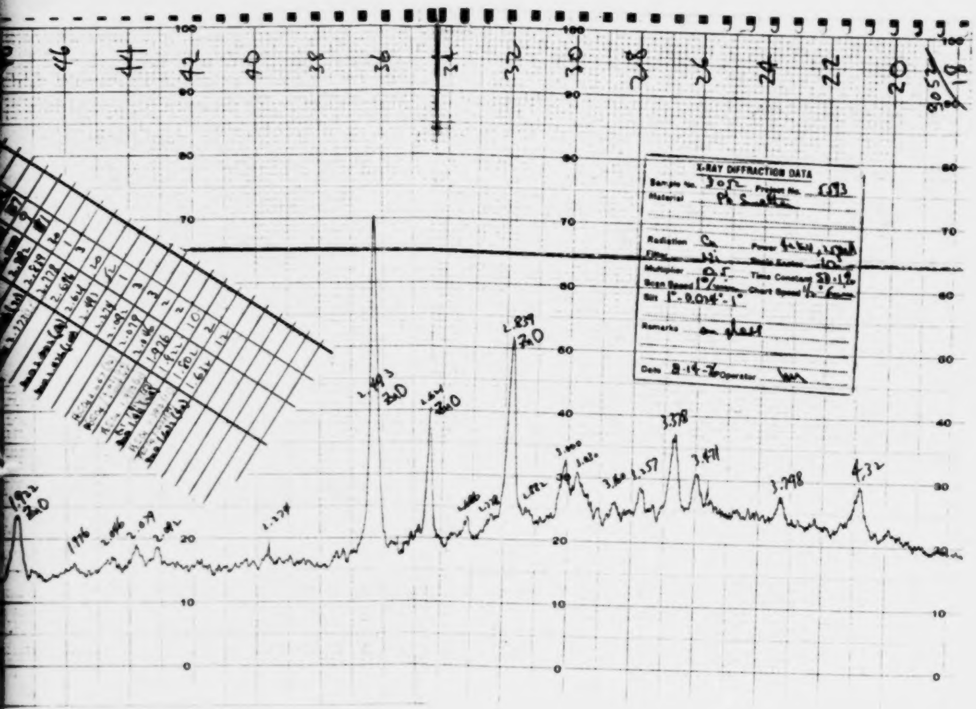
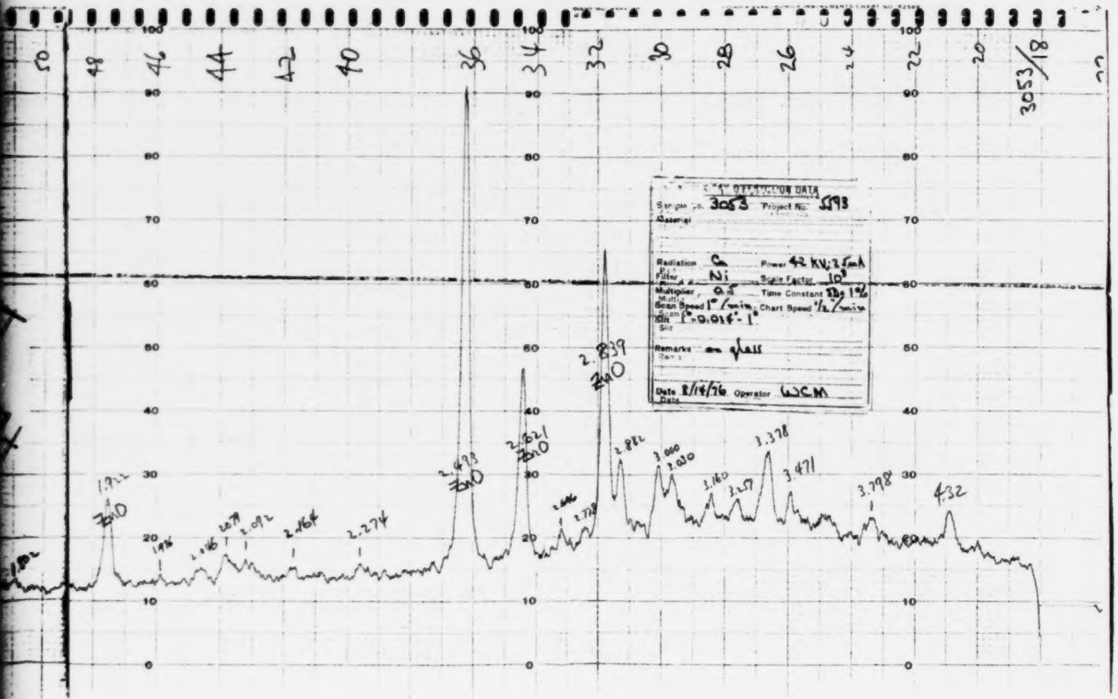


Figure G-46 - Run 26, Location 23, Filter 3053



X-RAY DIFFRACTION DATA
Sample No. 3052 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42 kV, 25 mA
Filter Ni Scale Factor 10³
Multiplier 0.5 Time Constant 3D 1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.018°-1°
Remarks on glass
Date 8-14-76 Operator WCM

e G-45 - Run 26, Location 23, Filter 3052



X-RAY DIFFRACTION DATA
Sample No. 3053 Project No. 5593
Material
Radiation Cu Power 42 KV; 25 mA
Filter Ni Scale Factor 10³
Multiplier 0.5 Time Constant 3D 1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.018°-1°
Remarks on glass
Date 8/14/76 Operator WCM

G-46 - Run 26, Location 23, Filter 3053

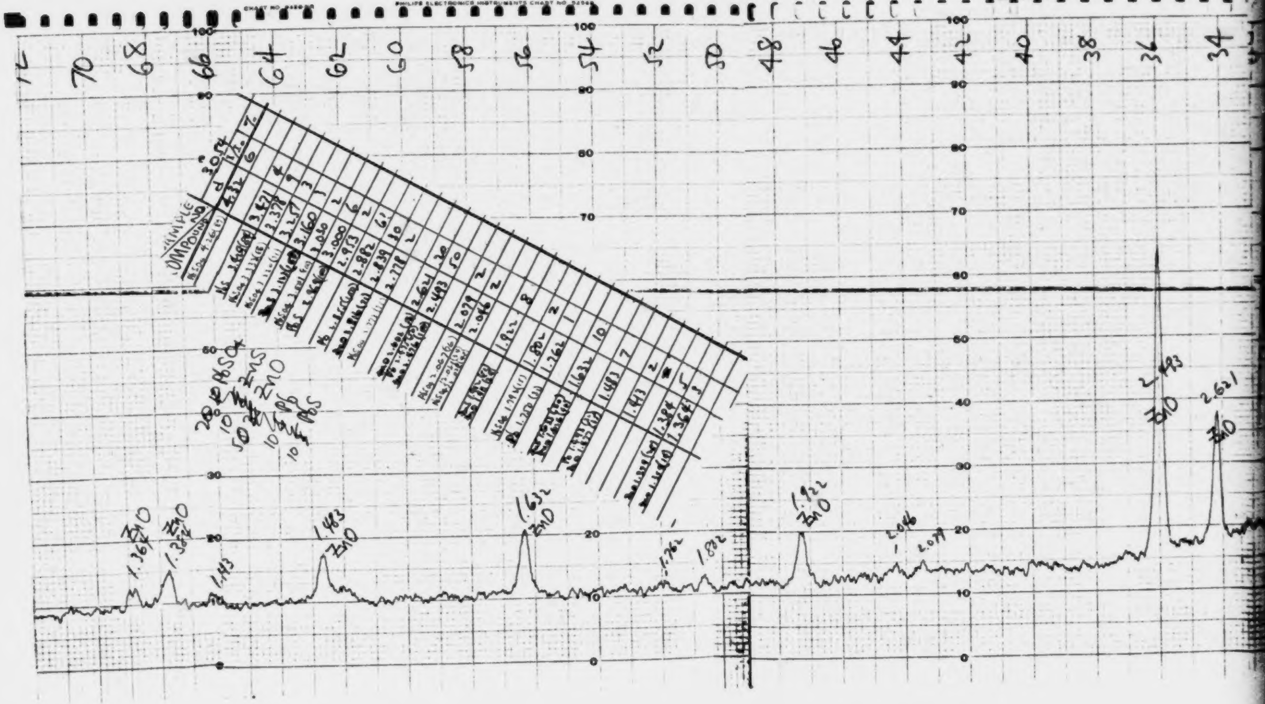


Figure G-47 - Run 26, Location 23, Filter 3054

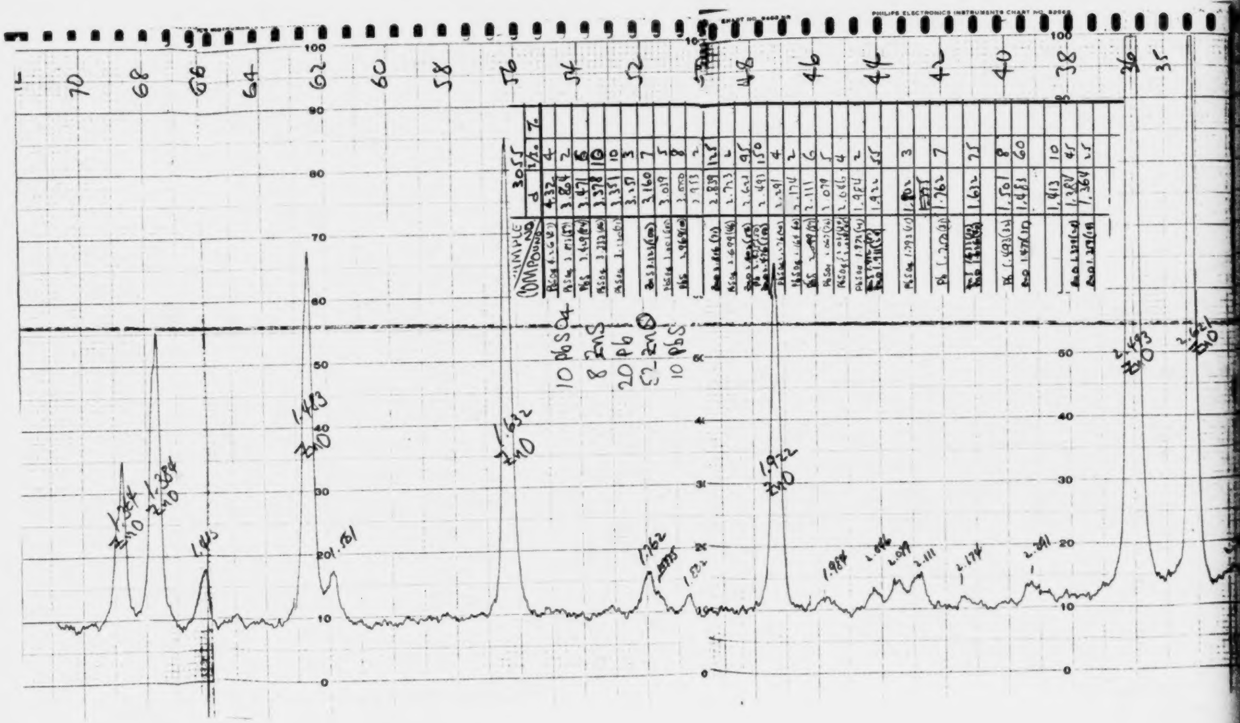
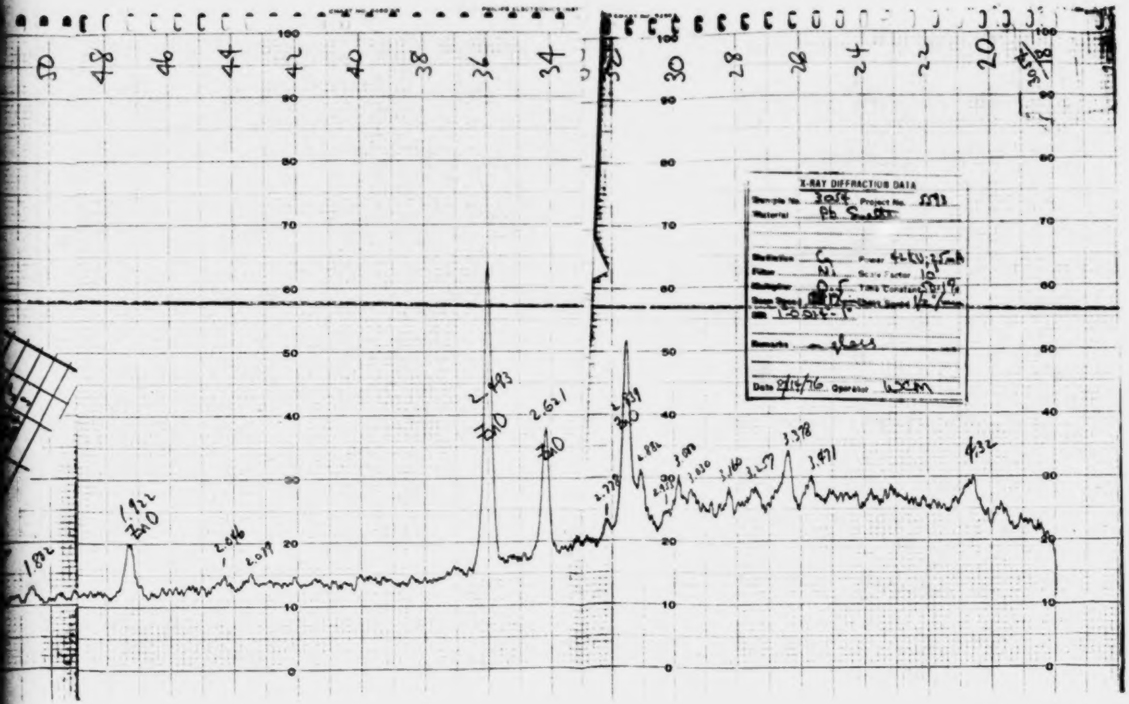
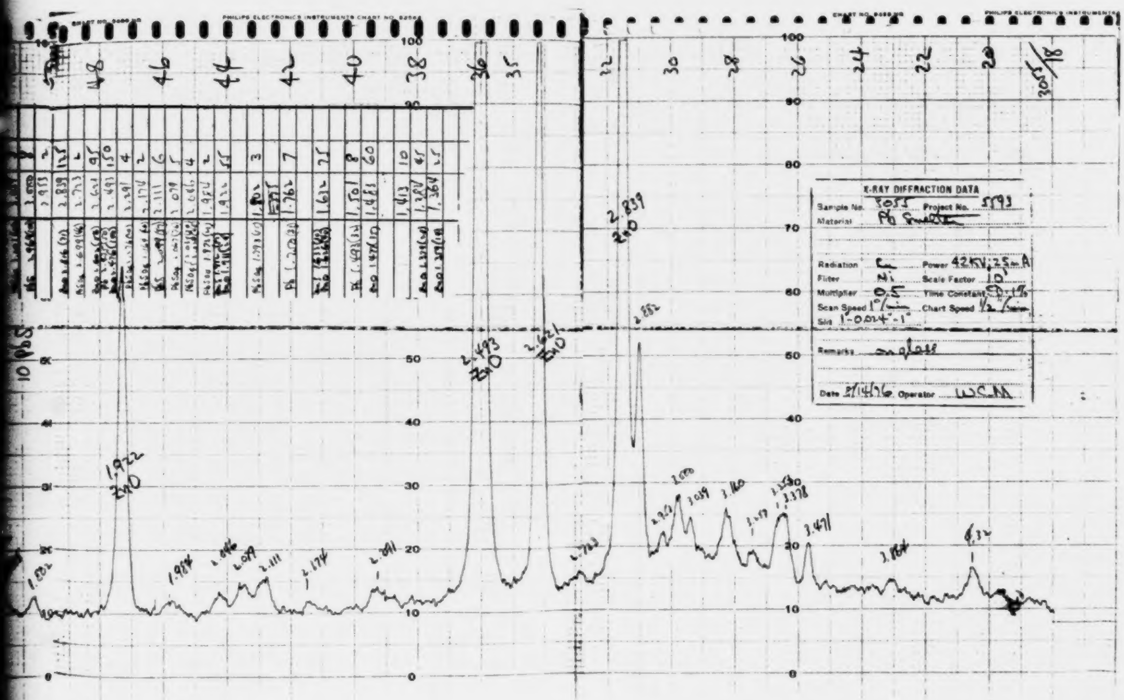


Figure G-48 - Run 26, Location 23, Filter 3055



X-RAY DIFFRACTION DATA
Sample No. 3054 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10
Multiplier 0.5 Time Constant 5.0; 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1-0.024-1°
Remarks on glass
Date 2/14/76 Operator WCM

G-47 - Run 26, Location 23, Filter 3054



X-RAY DIFFRACTION DATA
Sample No. 3055 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV; 25mA
Filter Ni Scale Factor 10
Multiplier 0.5 Time Constant 5.0; 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1-0.024"-1°
Remarks on glass
Date 2/14/76 Operator WCM

G-48 - Run 26, Location 23, Filter 3055

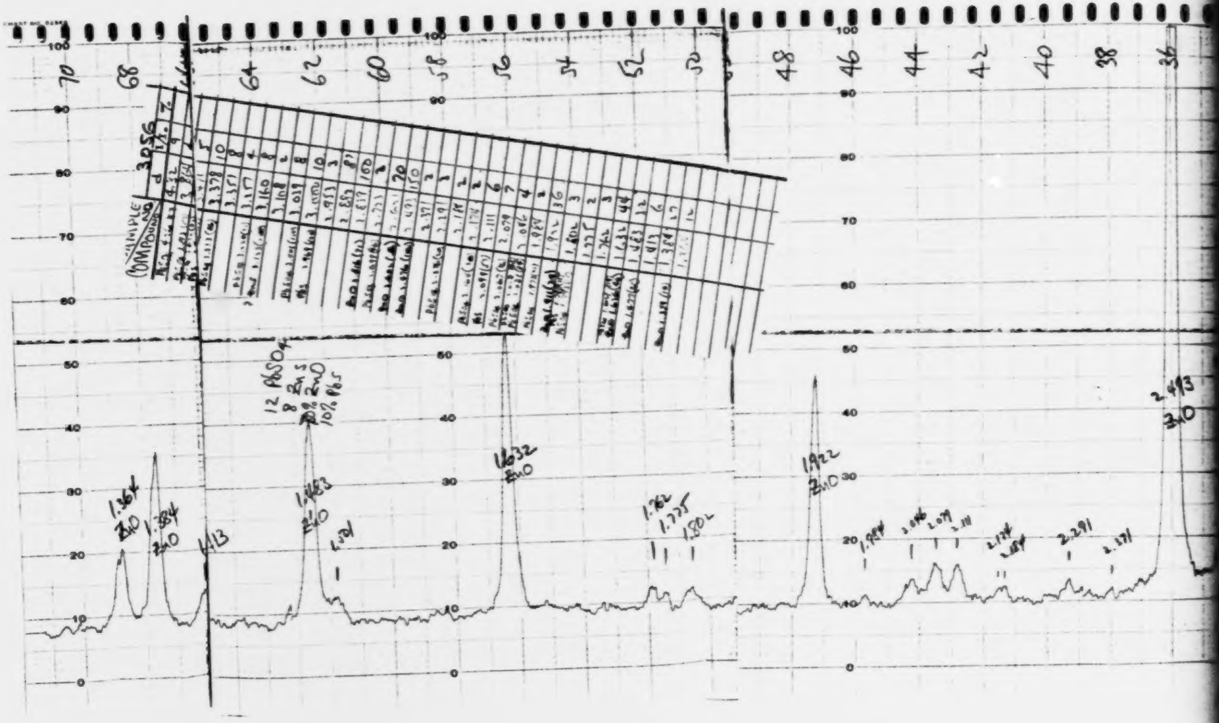


Figure G-49 - Run 26, Location 23, Filter 30

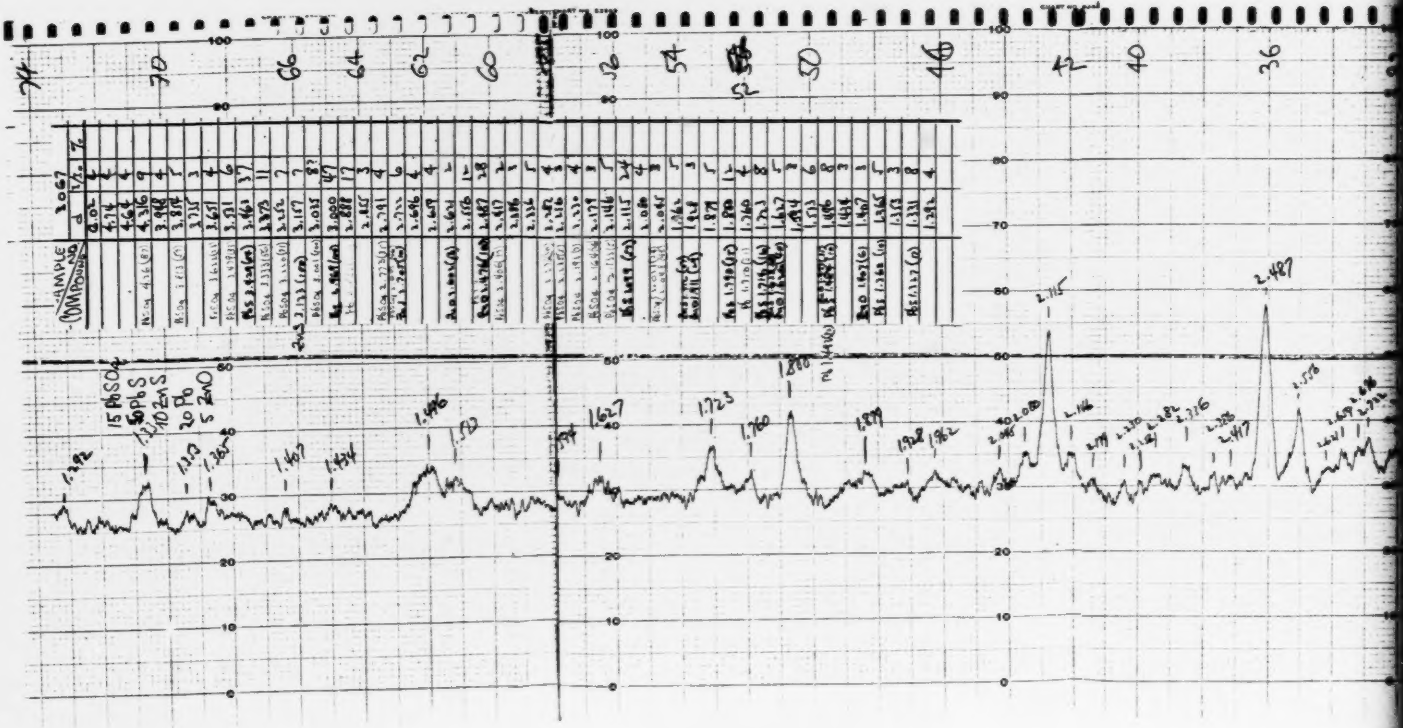


Figure G-50 - Run 29, Location 18, Filter 30

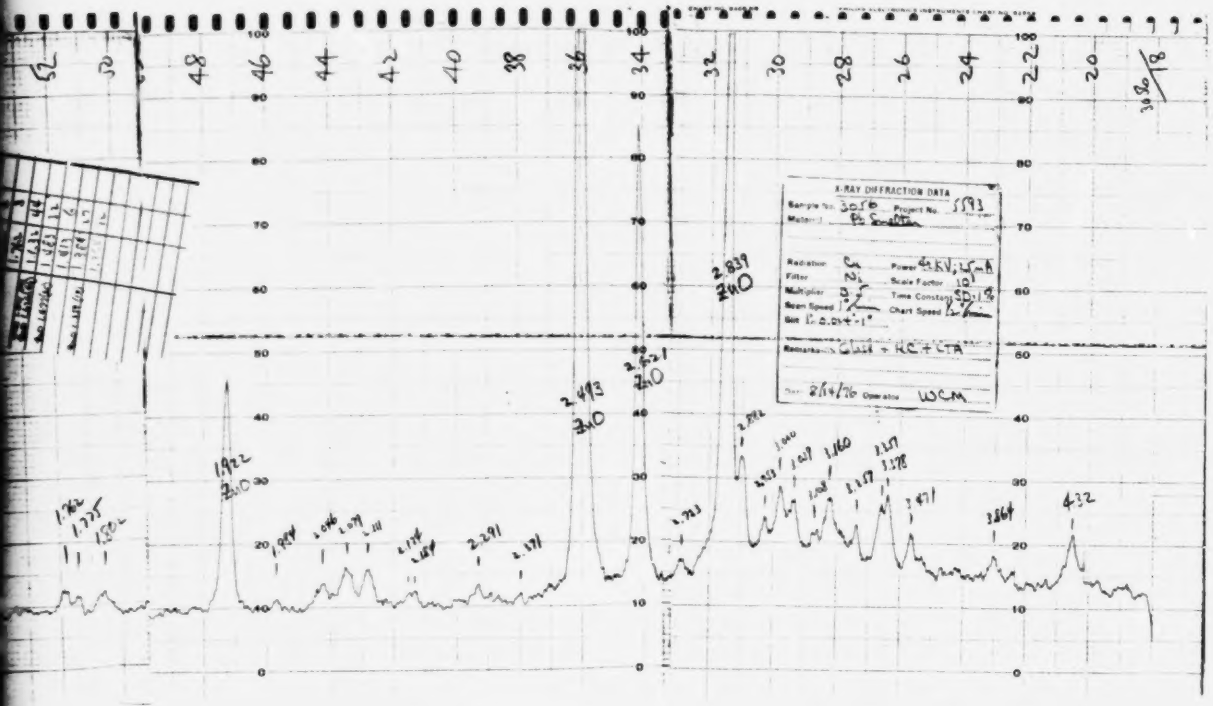


Figure G-49 - Run 26, Location 23, Filter 3056

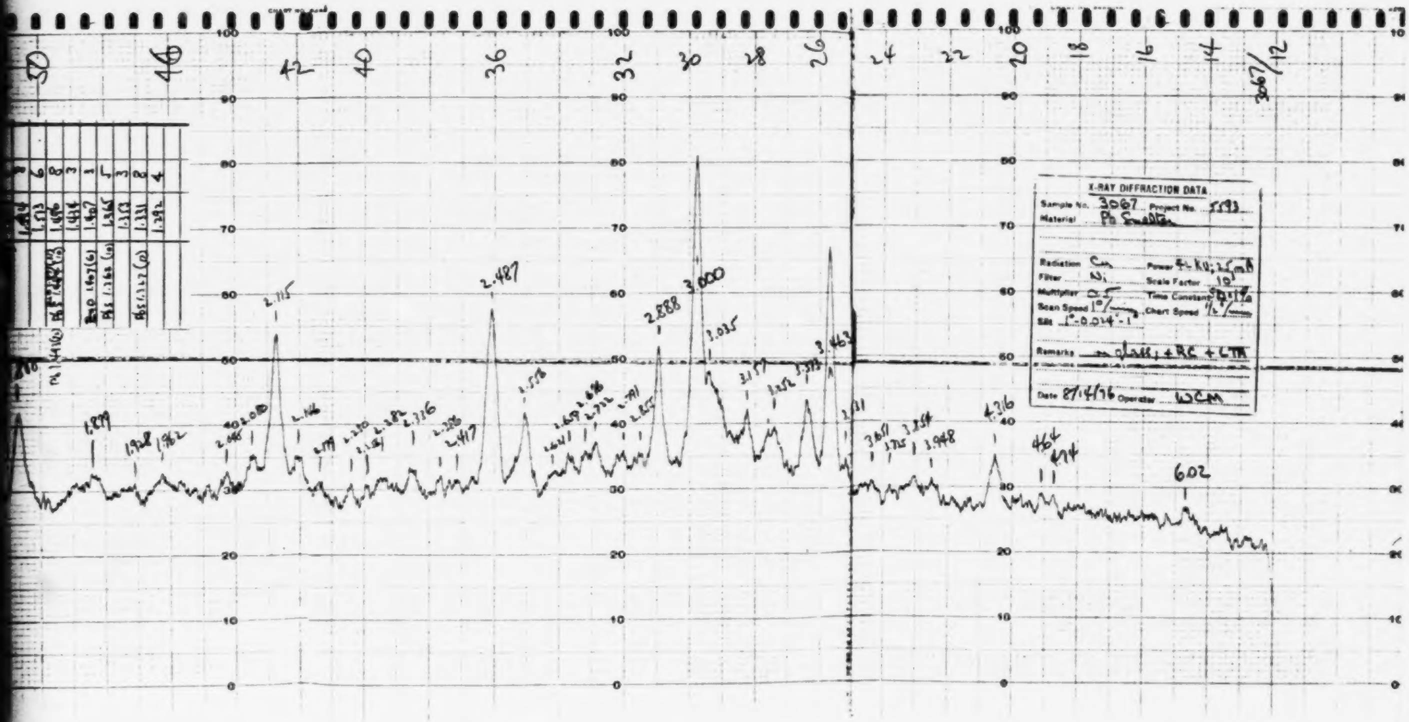


Figure G-50 - Run 29, Location 18, Filter 3067

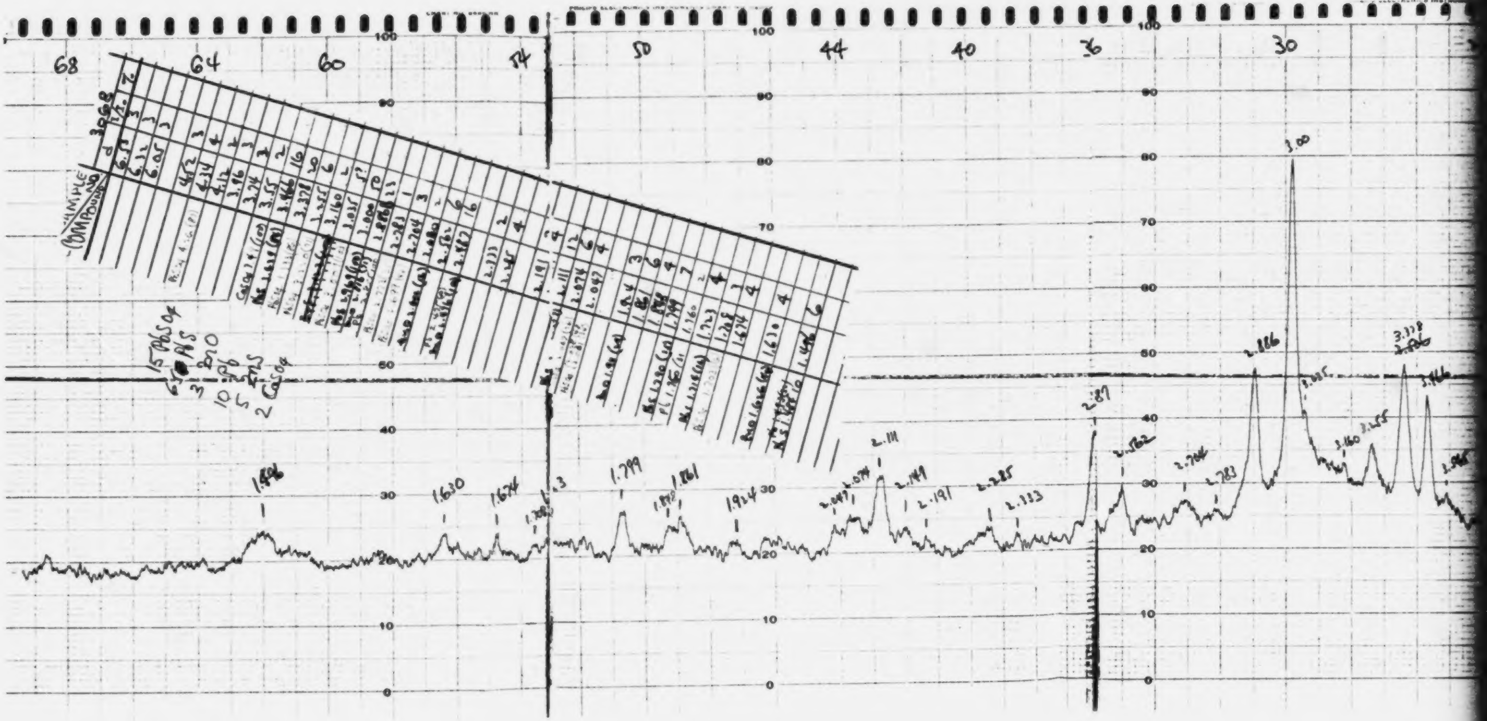


Figure G-51 - Run 29, Location 18, Filter 3068

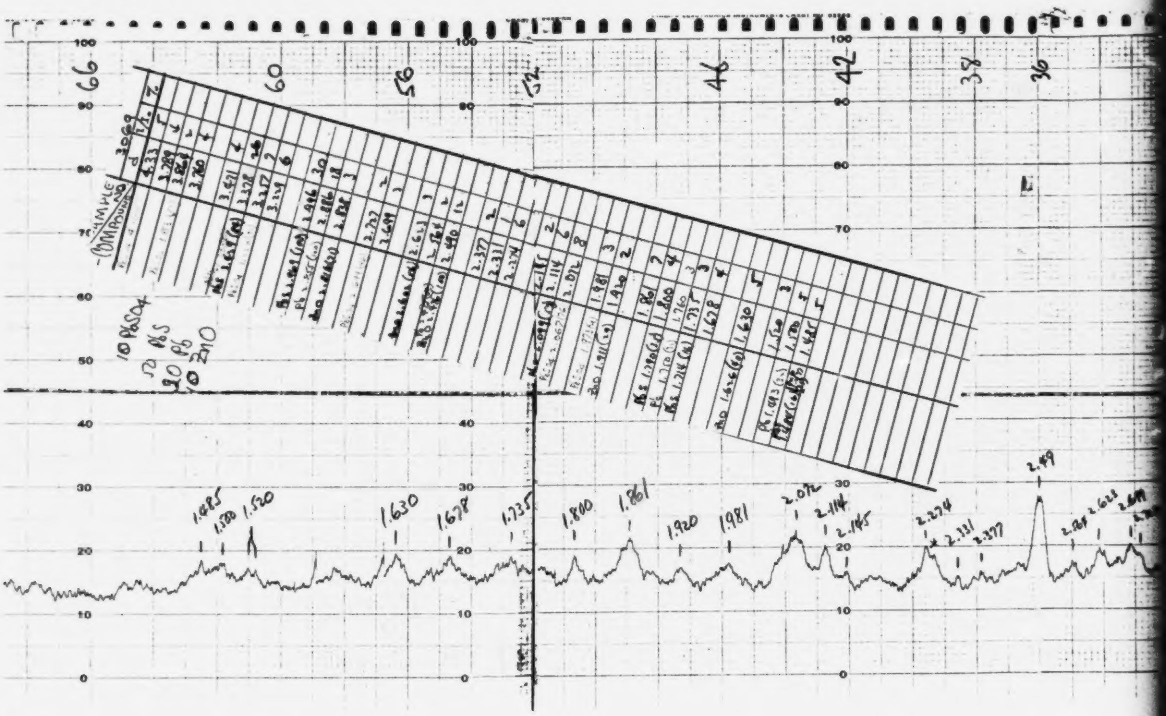
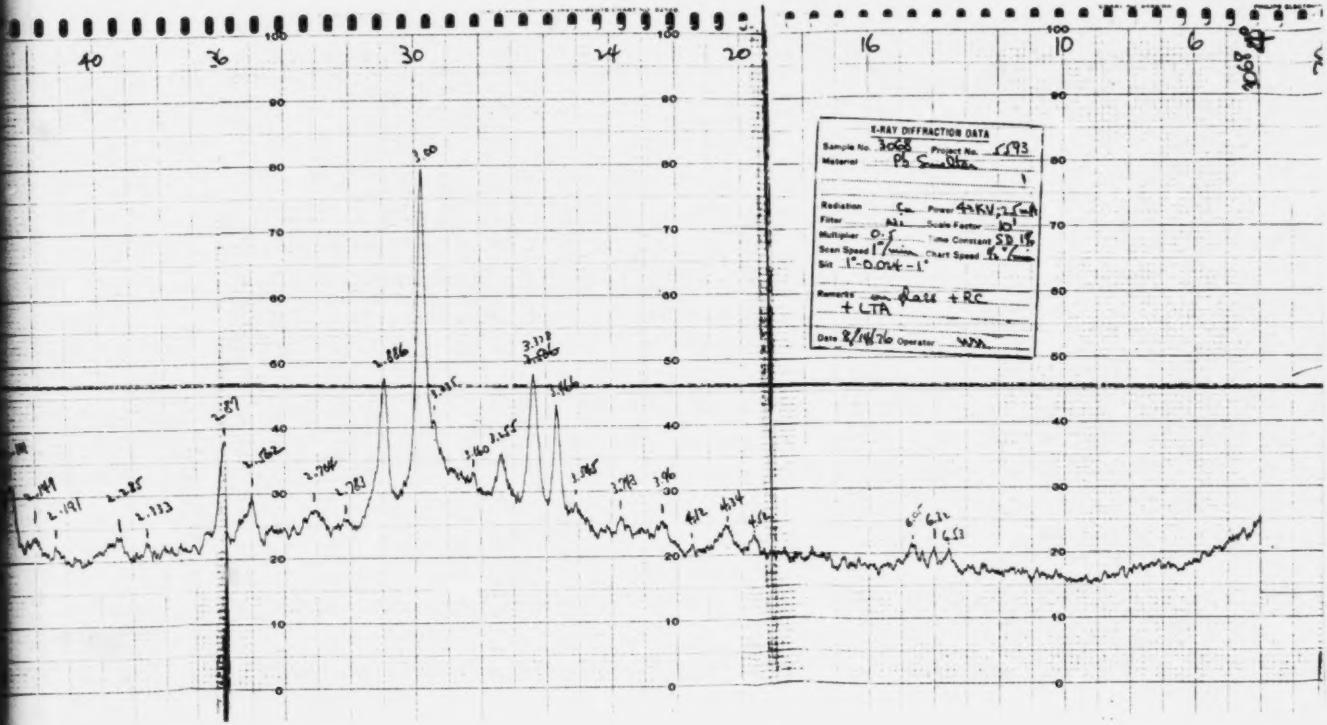


Figure G-52 - Run 29, Location 18, Filter 3069



X-RAY DIFFRACTION DATA

Sample No. 3068 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV; 25mA

Filter Ni Scale Factor 10³

Multiplier 0.5 Time Constant SD 1%

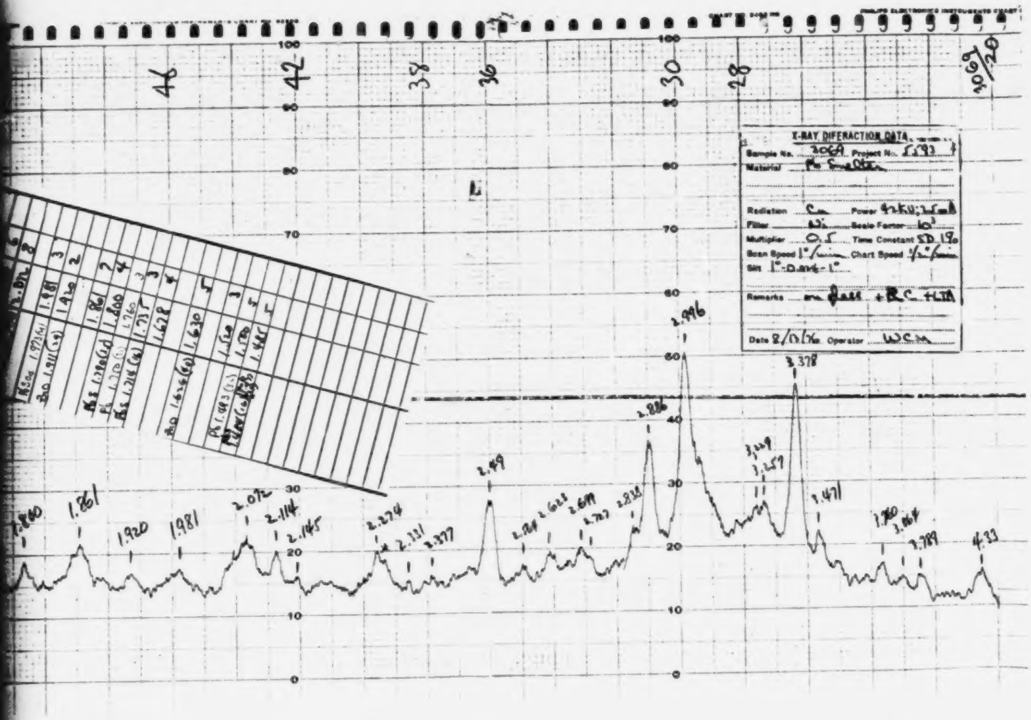
Scan Speed 1°/min Chart Speed ½"/min

Slit 1°-0.004-1°

Remarks on glass + RC + LTA

Date 8/14/76 Operator WM

G-51 - Run 29, Location 18, Filter 3068



X-RAY DIFFRACTION DATA

Sample No. 3069 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV; 25mA

Filter Ni Scale Factor 10³

Multiplier 0.5 Time Constant SD 1%

Scan Speed 1°/min Chart Speed ½"/min

Slit 1°-0.004-1°

Remarks on glass + RC + LTA

Date 8/13/76 Operator WCM

G-52 - Run 29, Location 18, Filter 3069

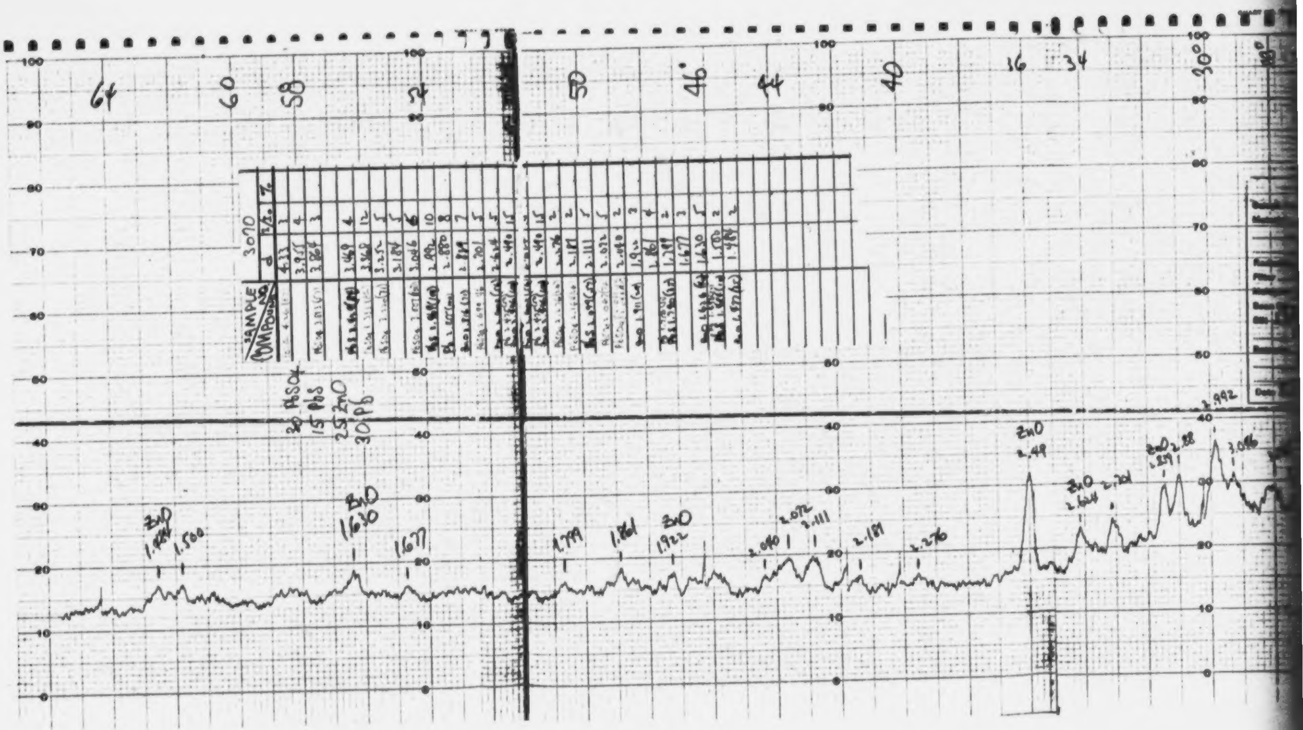


Figure G-53 - Run 29, Location 18, Filter 3070

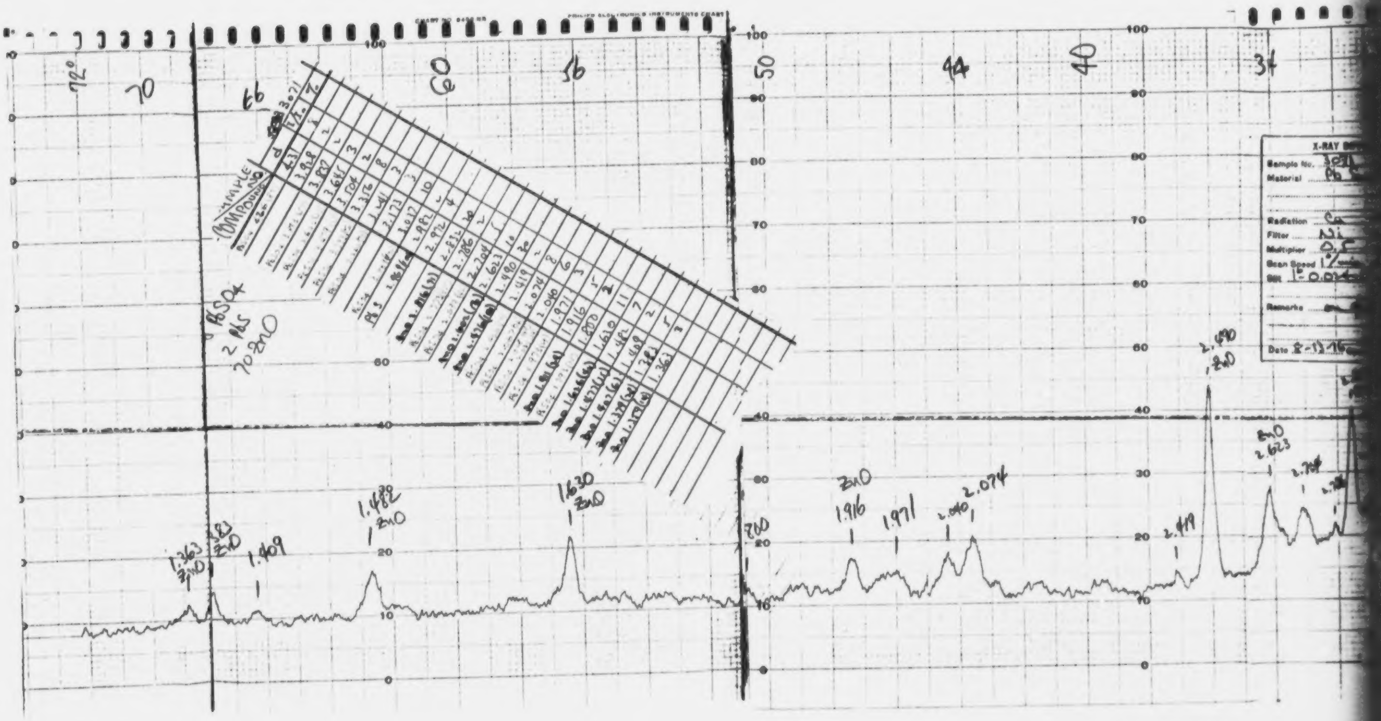
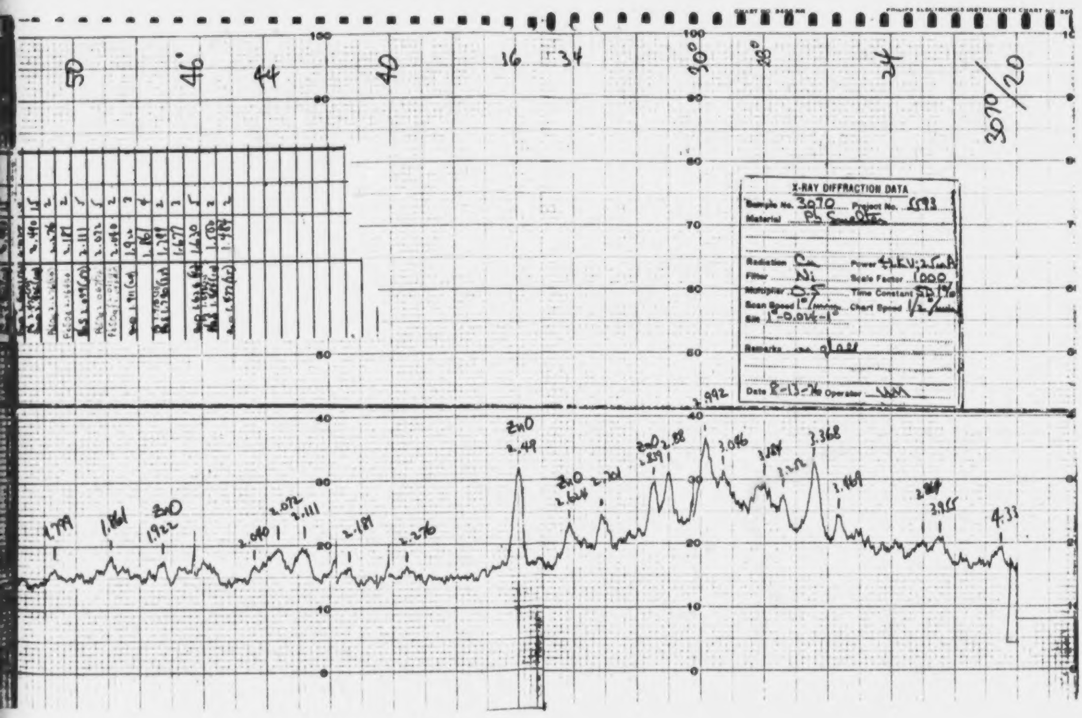


Figure G-54 - Run 29, Location 18, Filter 3071



X-RAY DIFFRACTION DATA

Sample No. 3070 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV;25mA

Filter Ni Scale Factor 1000

Multiplier 0.5 Time Constant 5D 1%

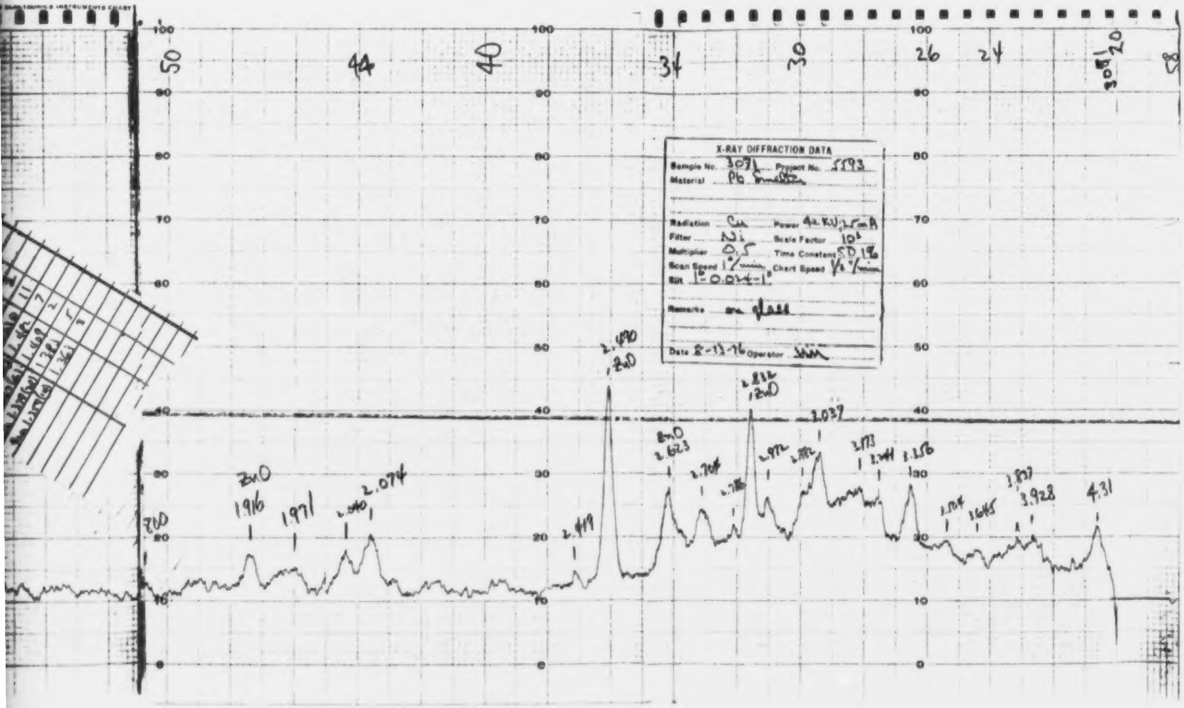
Scan Speed 1°/min. Chart Speed 1/2"/min

Slit 1°-0.024-1°

Remarks on glass

Date 8-13-76 Operator VAM

gure G-53 - Run 29, Location 18, Filter 3070



X-RAY DIFFRACTION DATA

Sample No. 3071 Project No. 5593

Material Pb Smelter

Radiation Cu Power 42KV;25mA

Filter Ni Scale Factor 10^3

Multiplier 0.5 Time Constant 5D 1%

Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.024-1°

Remarks on glass

Date 8-13-76 Operator VAM

gure G-54 - Run 29, Location 18, Filter 3071

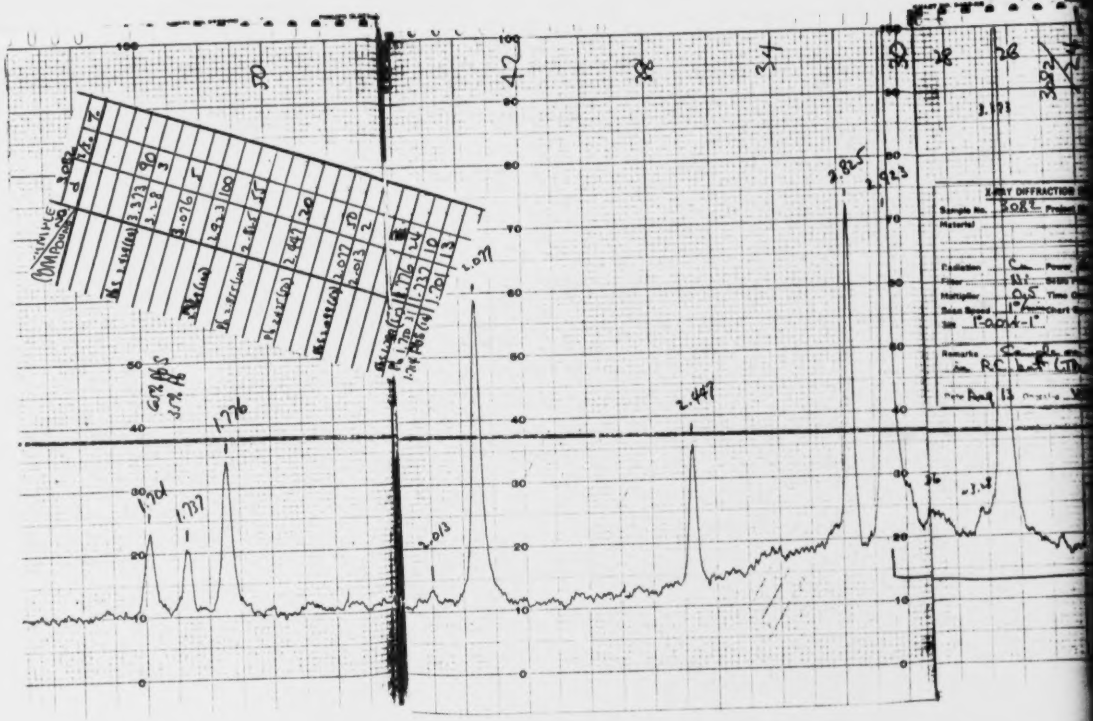


Figure G-55 - Run 31, Location 17, Filter 3082

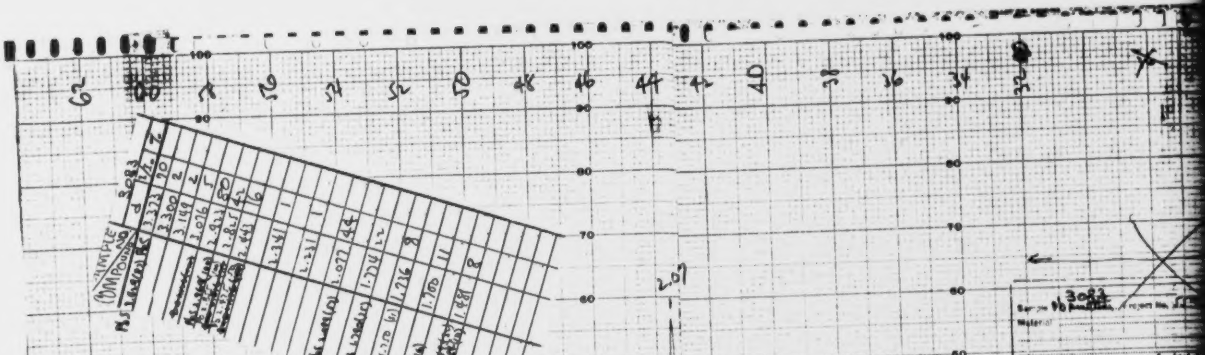
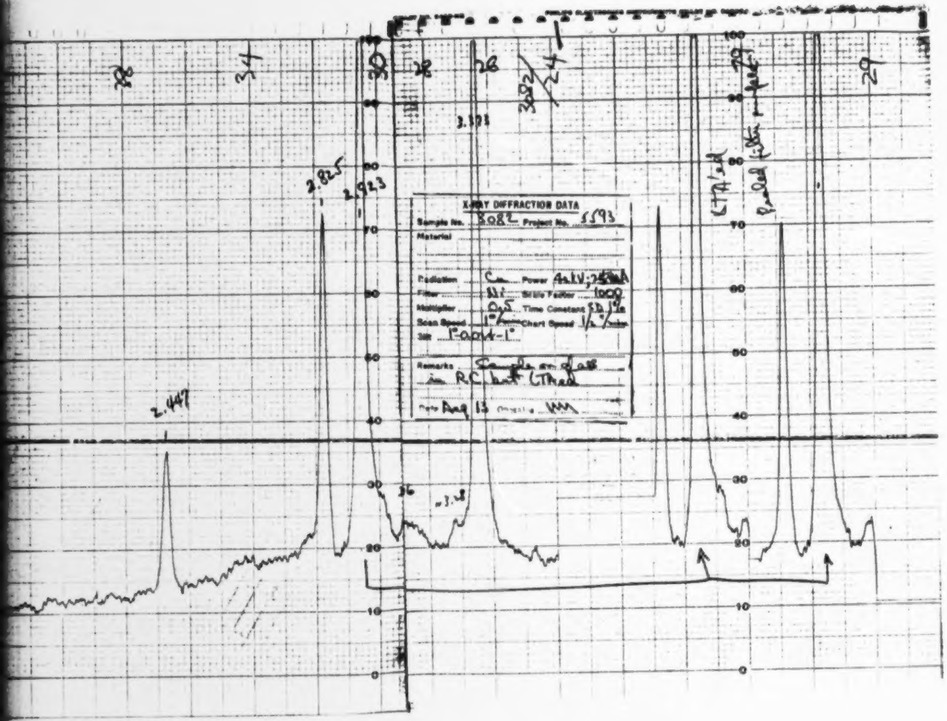
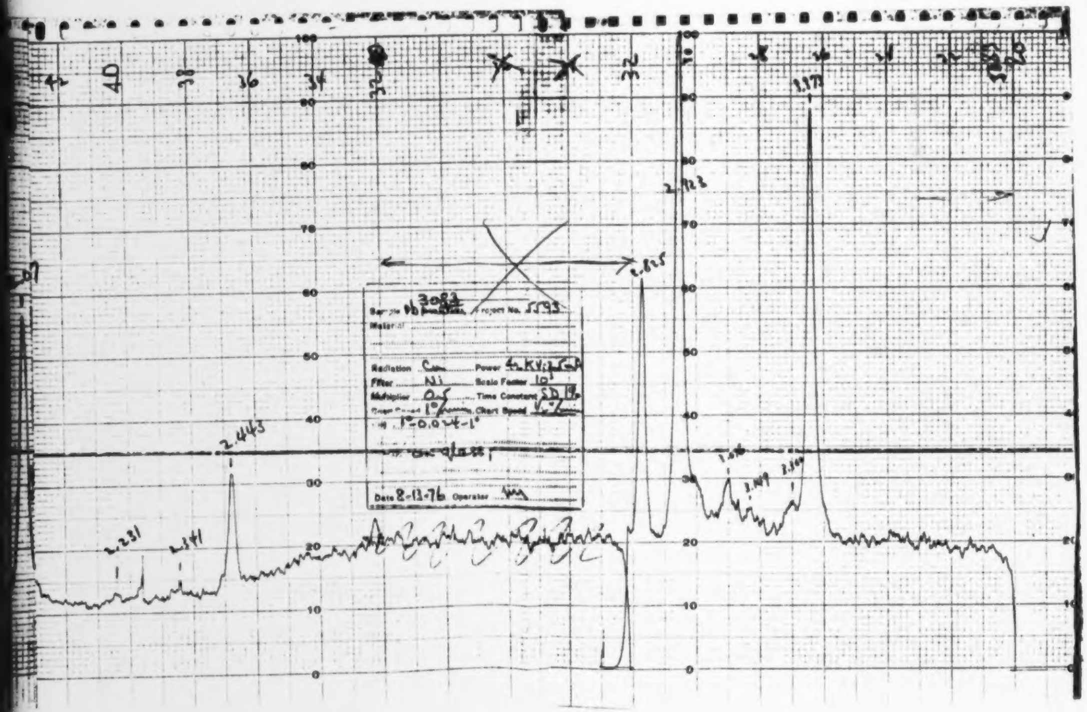


Figure G-56 - Run 31, Location 17, Filter 3083



X-RAY DIFFRACTION DATA
Sample No. 3082 Project No. 5593
Material
Radiation Cu Power 4.kV; 25mA
Filter Ni Scale Factor 1000
Multiplier 0.5 Time Constant S.D. 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.004-1°
Remarks Sample on glass in R.C. but CTAed
Date Aug 13 Operator

-55 - Run 31, Location 17, Filter 3082



Sample No. 3083 Project No. 5593
Material
Radiation Cu Power 45KV; 25mA
Filter Ni Scale Factor 10³
Multiplier 0.5 Time Constant S.D. 1%
Scan Speed 1°/min Chart Speed ½"/min
Slit 1°-0.004-1°
on glass
Date 8-13-76 Operator

-56 - Run 31, Location 17, Filter 3083

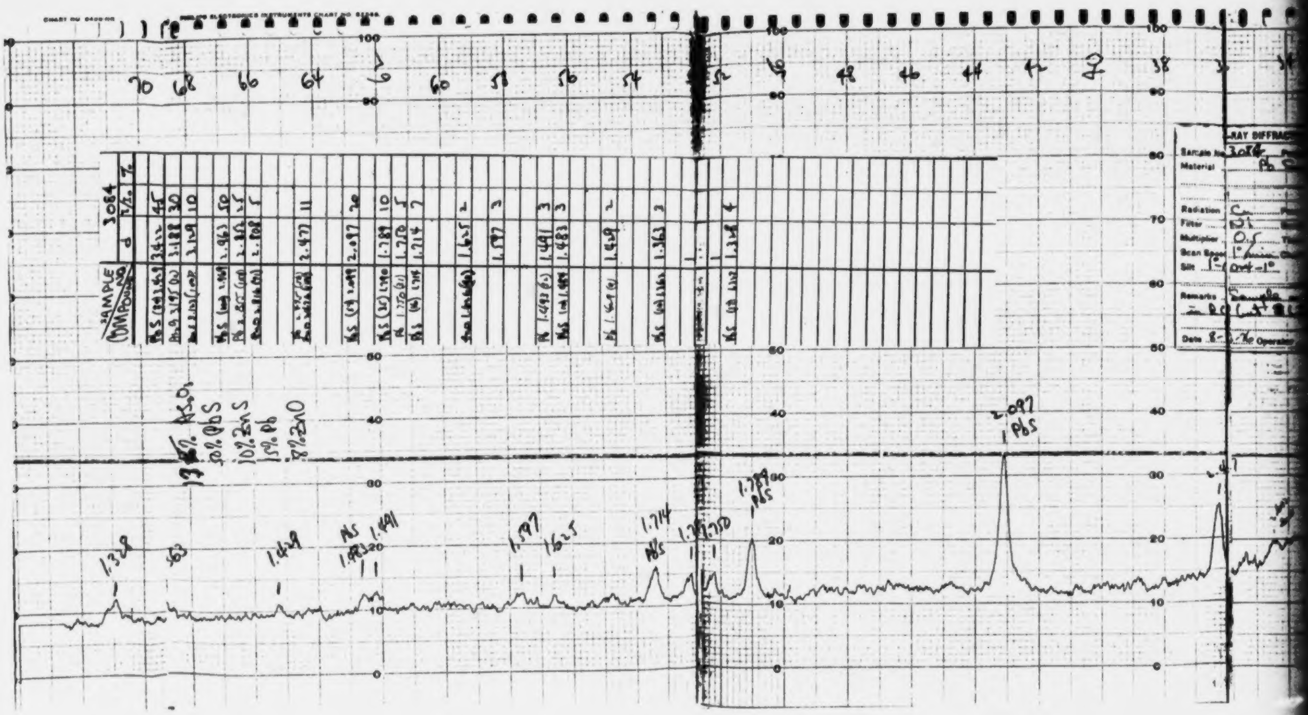


Figure G-57 - Run 31, Location 17, Filter 3084

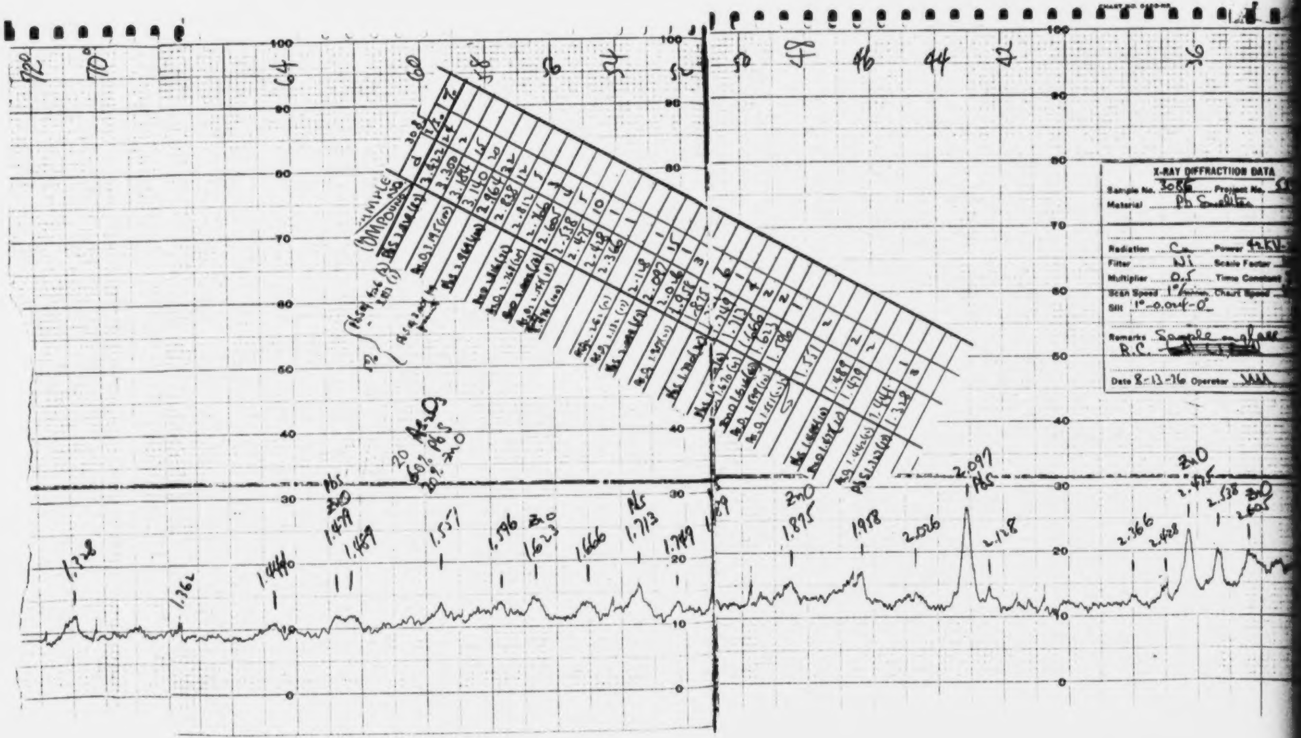
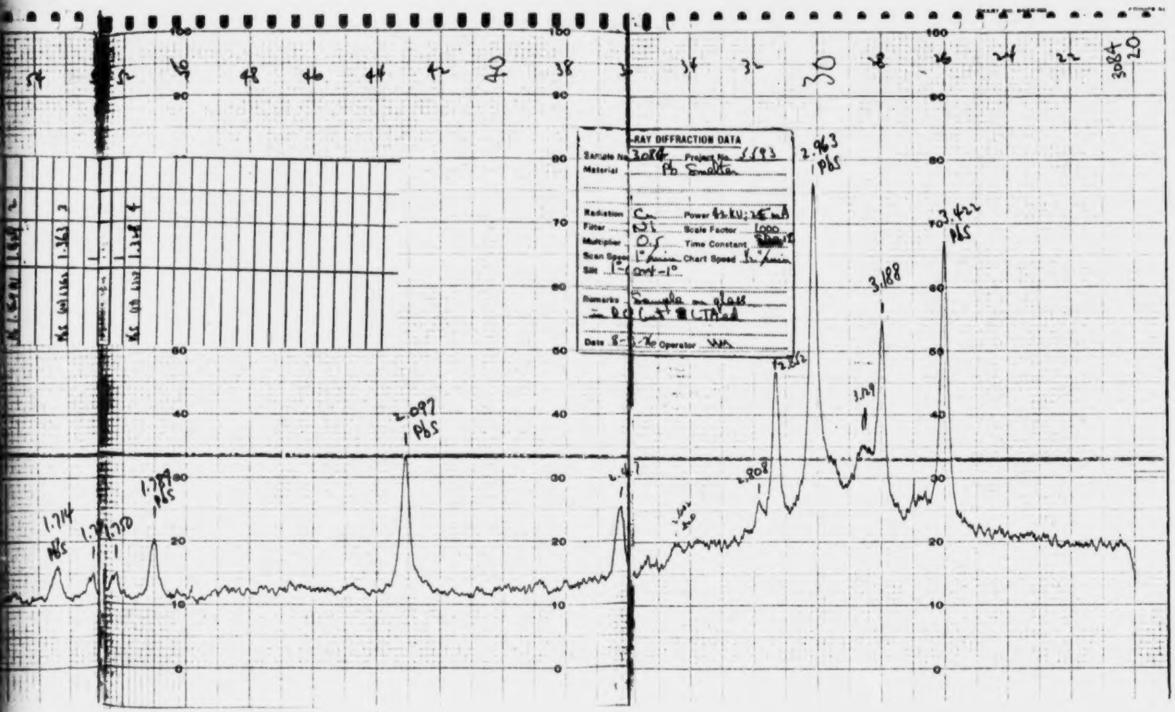
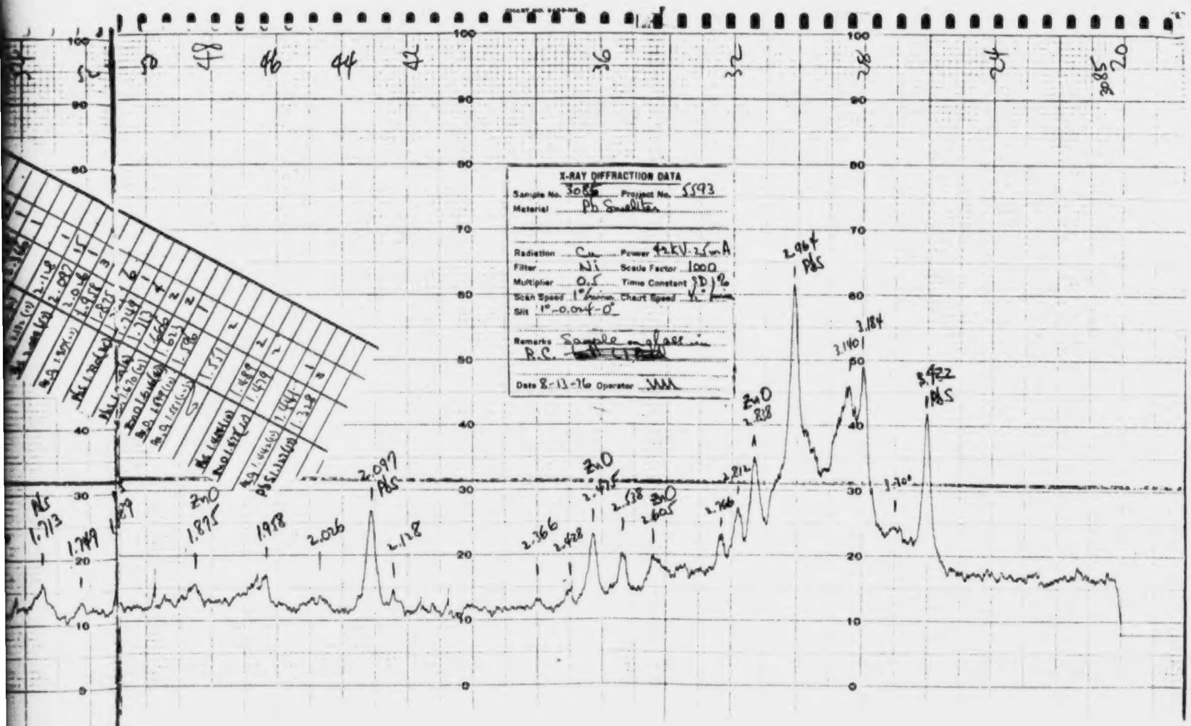


Figure G-58 - Run 31, Location 17, Filter 3085



X-RAY DIFFRACTION DATA
Sample No. 3084 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42 kV; 25 mA
Filter Ni Scale Factor 1000
Multiplier 0.5 Time Constant [illegible]
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.004-1°
Remarks Sample on glass in R.C. [illegible] LTA'ed
Date 8-[illegible]-76 Operator WM

gure G-57 - Run 31, Location 17, Filter 3084



X-RAY DIFFRACTION DATA
Sample No. 3085 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42 kV-25 mA
Filter Ni Scale Factor 1000
Multiplier 0.5 Time Constant 5D 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.004-0°
Remarks Sample on glass in R.C. ~~[illegible]~~
Date 8-13-76 Operator WM

gure G-58 - Run 31, Location 17, Filter 3085

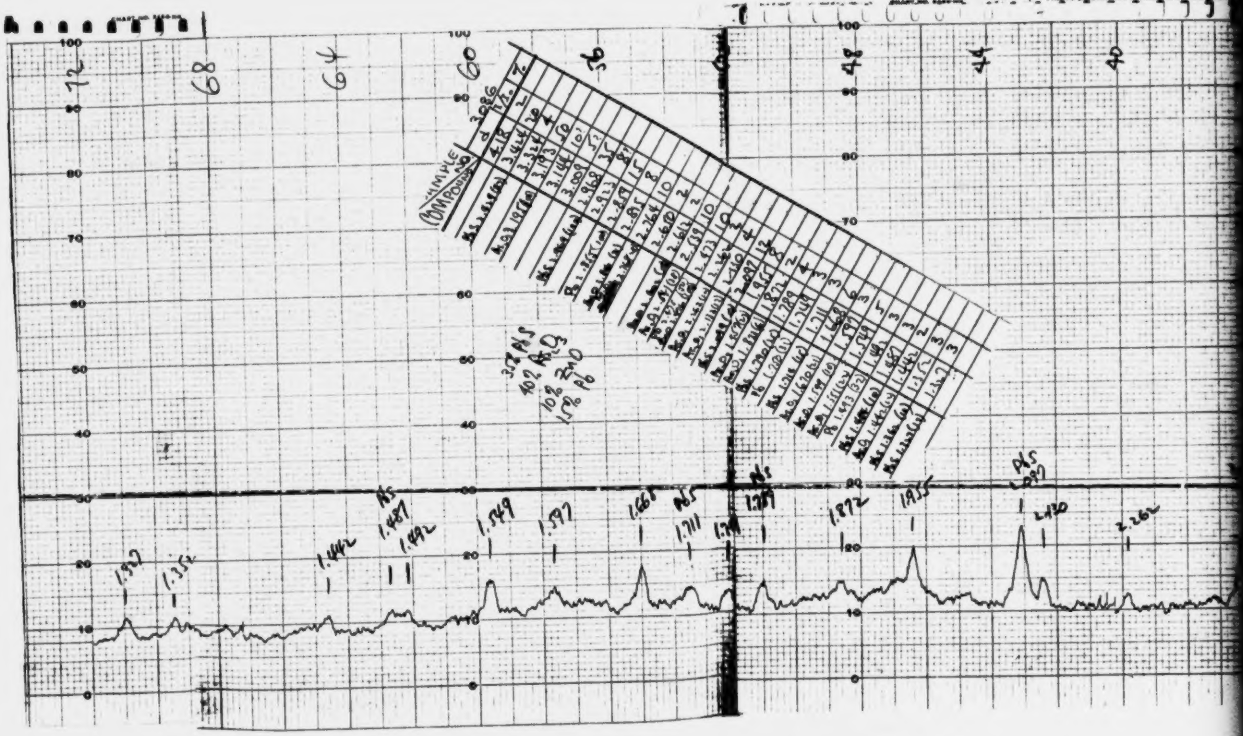


Figure G-59 - Run 31, Location 17, Filter 308

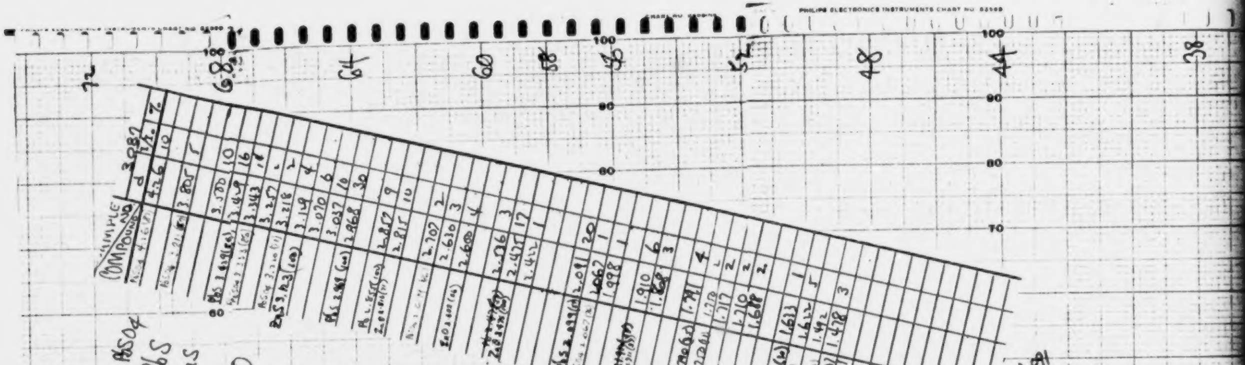
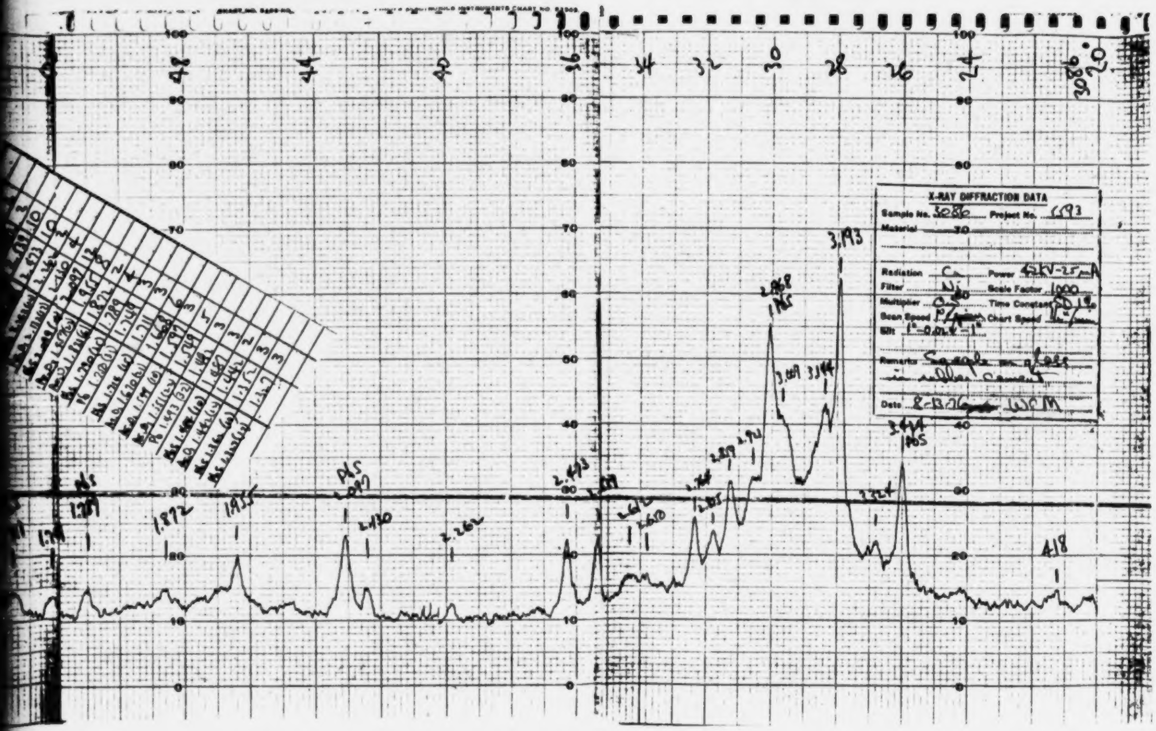
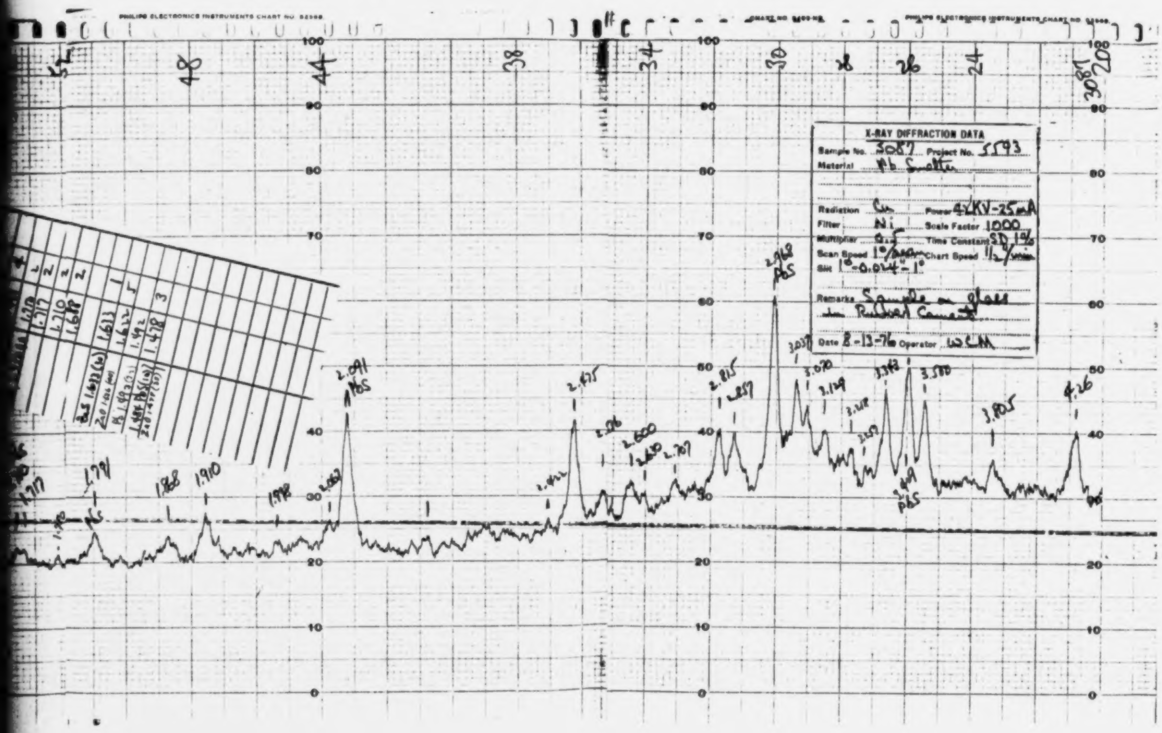


Figure G-60 - Run 33, Location 20, Filter 308



X-RAY DIFFRACTION DATA
Sample No. 3086 Project No. 5593
Material
Radiation Cu Power 42KV-25mA
Filter Ni Scale Factor 1000
Multiplier 0.5 Time Constant SD 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.024"-1°
Remarks Sample on glass in rubber cement
Date 8-13-76 WCM

G-59 - Run 31, Location 17, Filter 3086



X-RAY DIFFRACTION DATA
Sample No. 3087 Project No. 5593
Material Pb Smelter
Radiation Cu Power 42KV-25mA
Filter Ni Scale Factor 1000
Multiplier 0.5 Time Constant SD 1%
Scan Speed 1°/min Chart Speed 1/2"/min
Slit 1°-0.024"-1°
Remarks Sample on glass in Rubber Cement
Date 8-13-76 Operator WCM

G-60 - Run 33, Location 20, Filter 3087

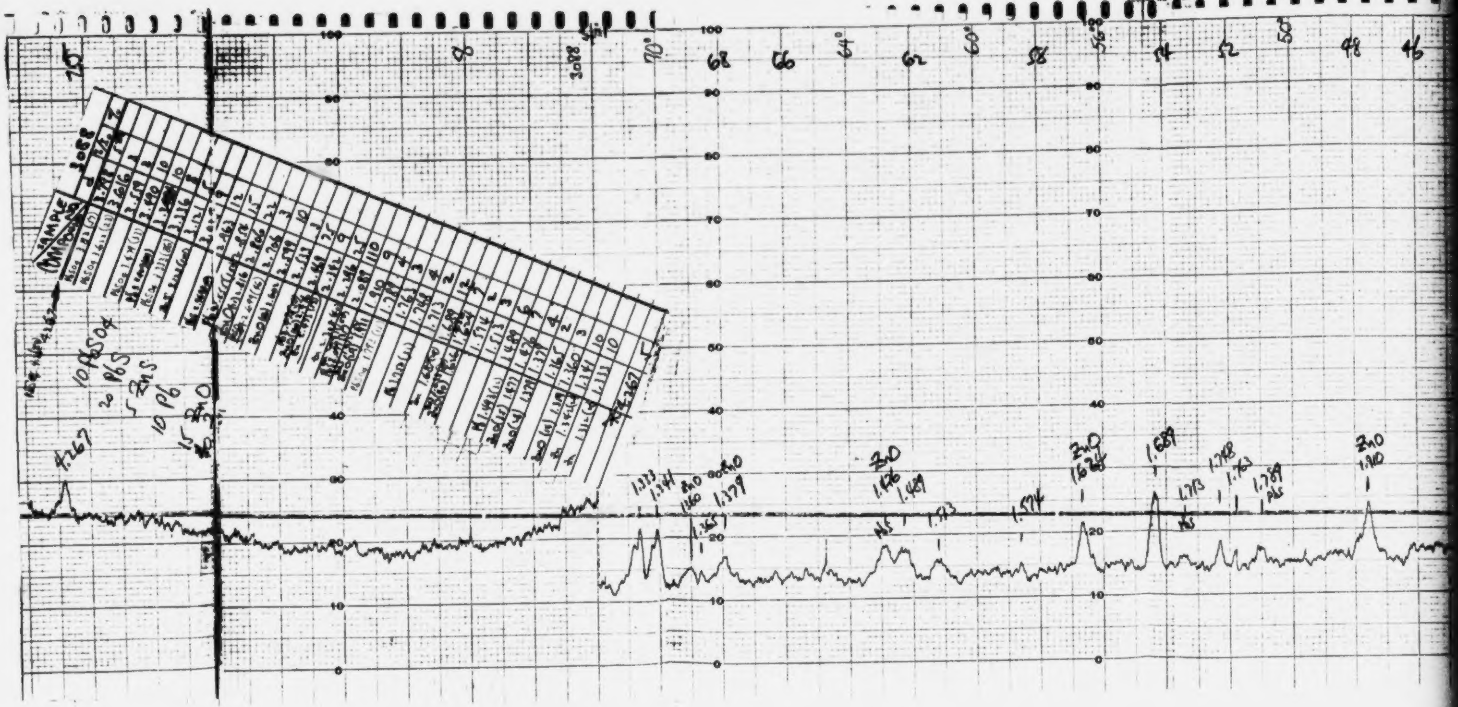


Figure G-61 - Run 33, Location 20, Filter 3088

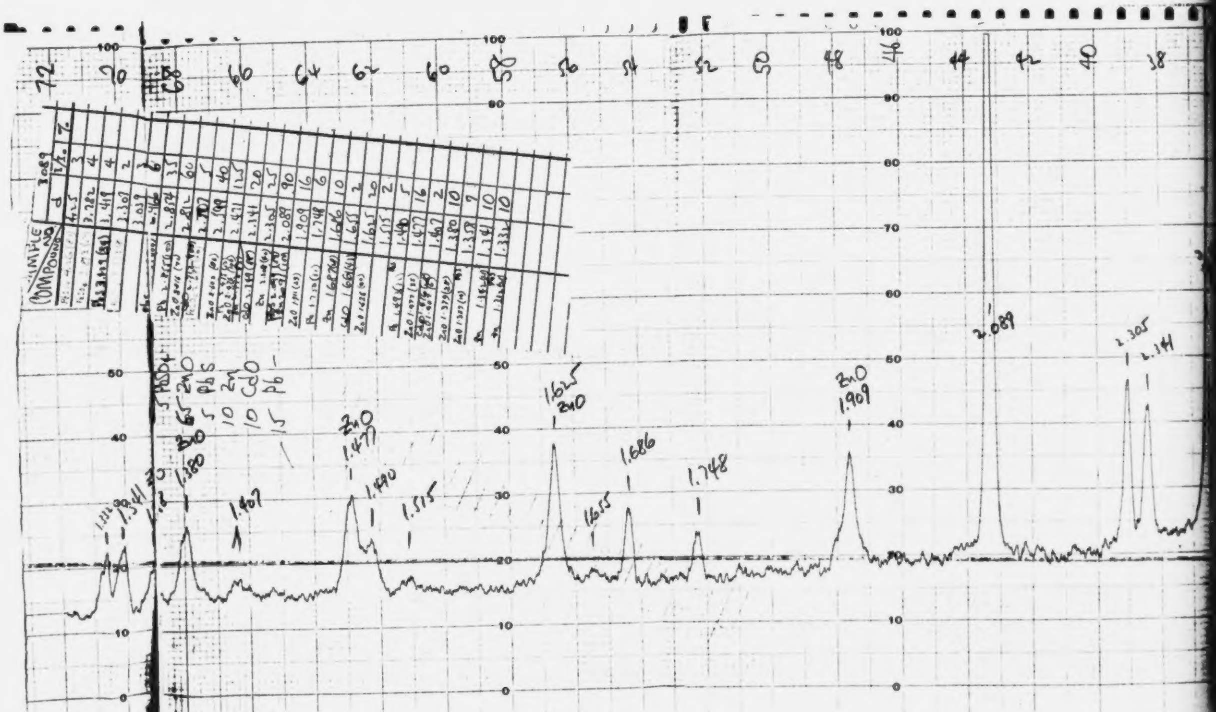
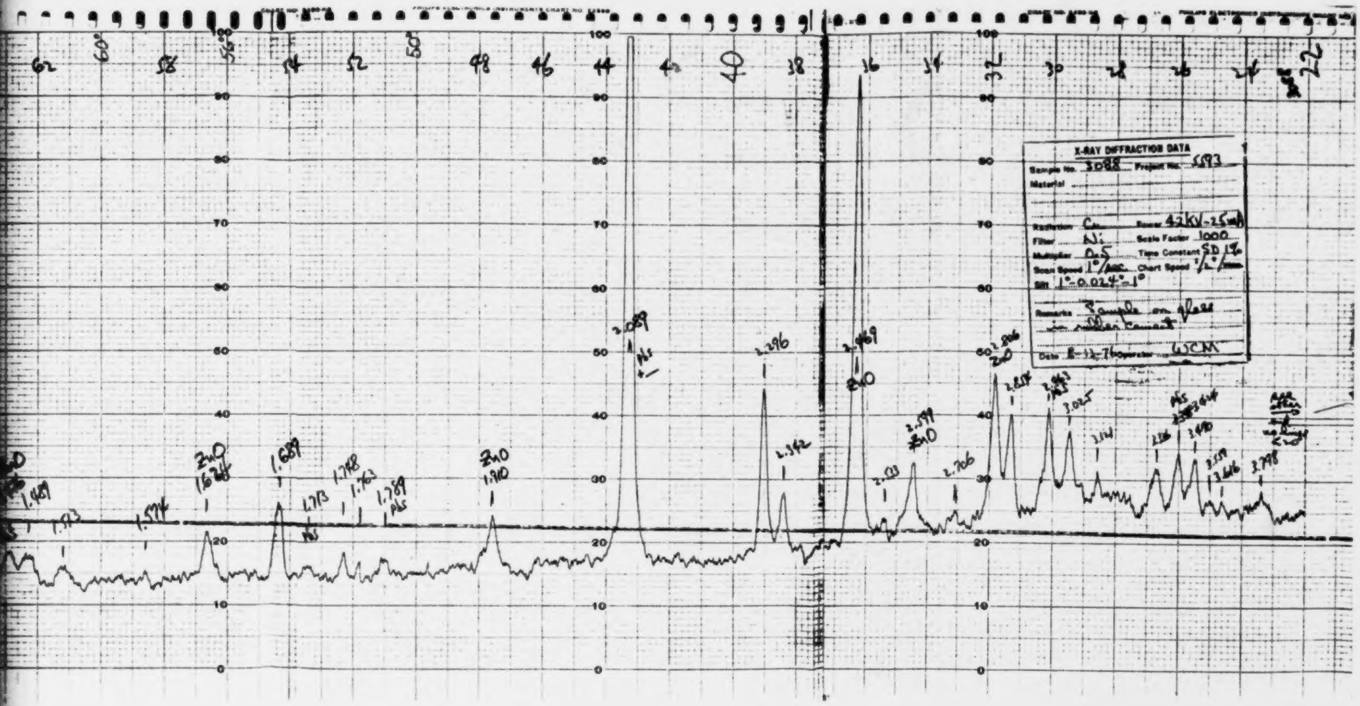


Figure G-62 - Run 33, Location 20, Filter 308



X-RAY DIFFRACTION DATA

Sample No. 3088 Project No. 5593

Material

Radiation Cu Power 42KV-25mA

Filter Ni Scale Factor 1000

Multiplier 0.5 Time Constant SD 1%

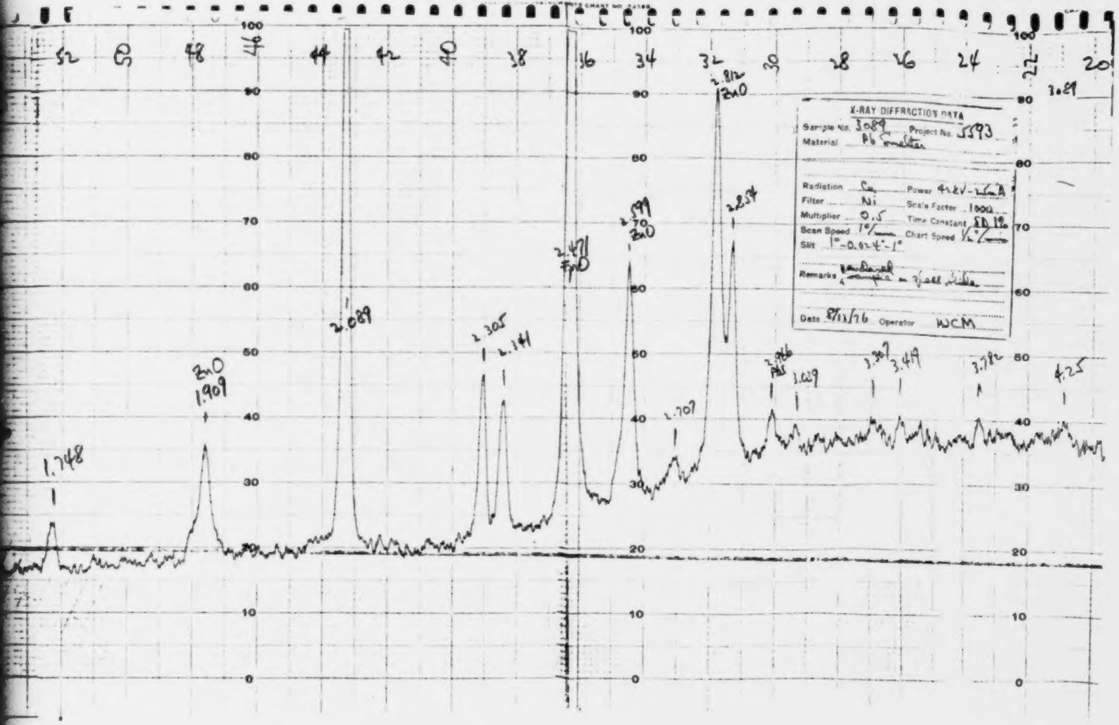
Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.024°-1°

Remarks Sample on glass in rubber cement

Date 8-12-76 Operator WCM

G-61 - Run 33, Location 20, Filter 3088



X-RAY DIFFRACTION DATA

Sample No. 3089 Project No. 5593

Material Pb smelter

Radiation Cu Power 42kV-25mA

Filter Ni Scale Factor 1000

Multiplier 0.5 Time Constant SD 1%

Scan Speed 1°/min Chart Speed 1/2"/min

Slit 1°-0.024°-1°

Remarks [illegible] on glass slide

Date 8/12/76 Operator WCM

G-62 - Run 33, Location 20, Filter 3089

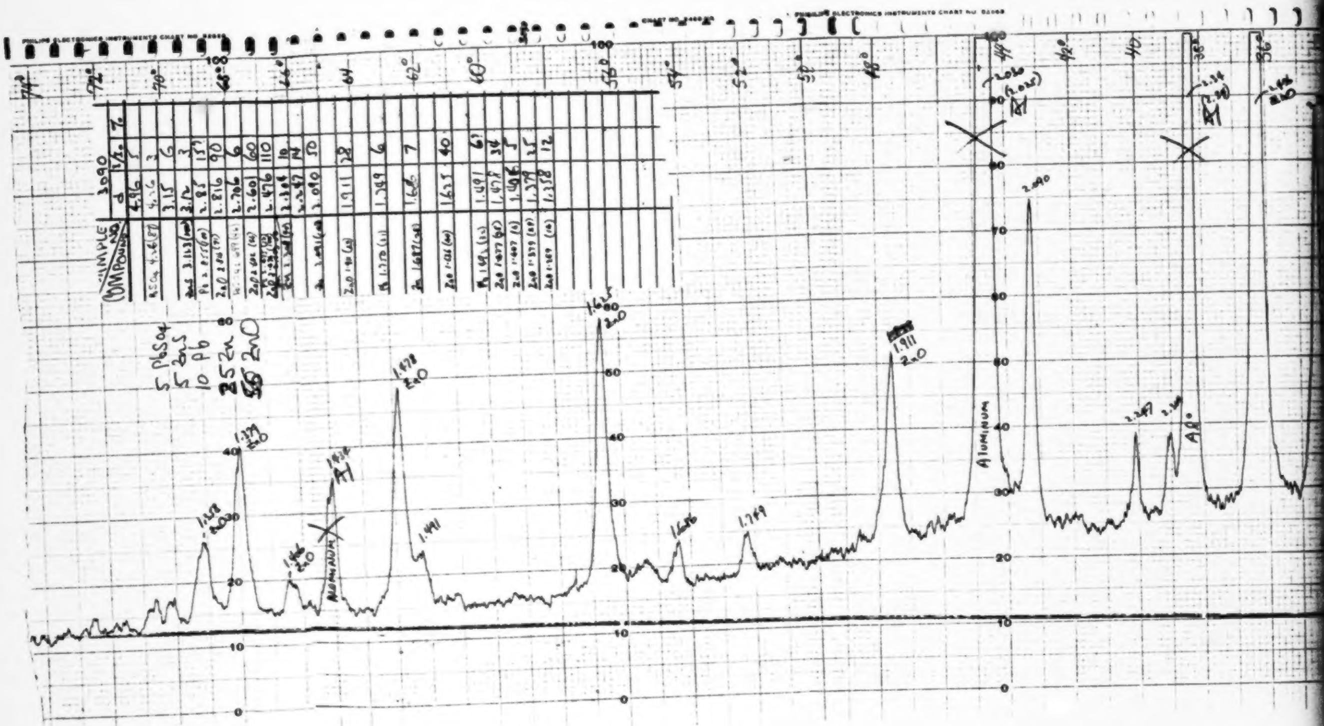


Figure G-63 - Run 33, Location 20, Filter 3090

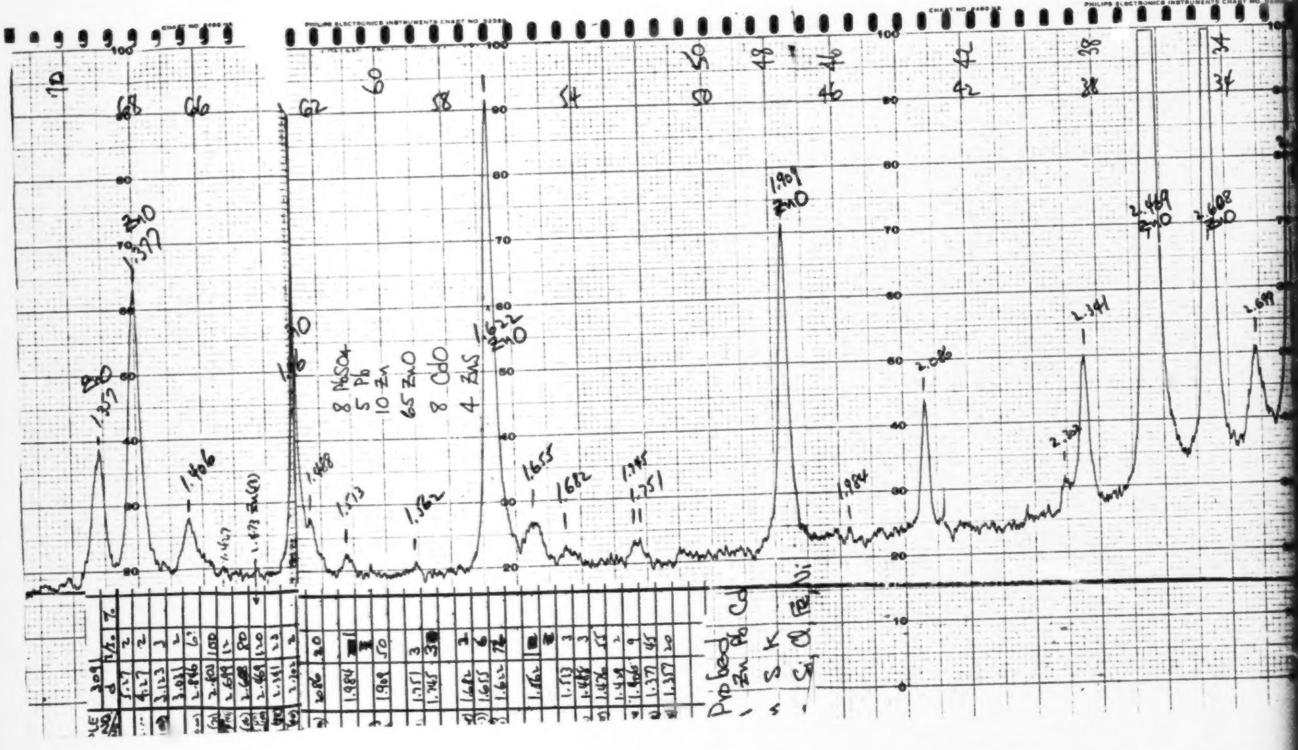
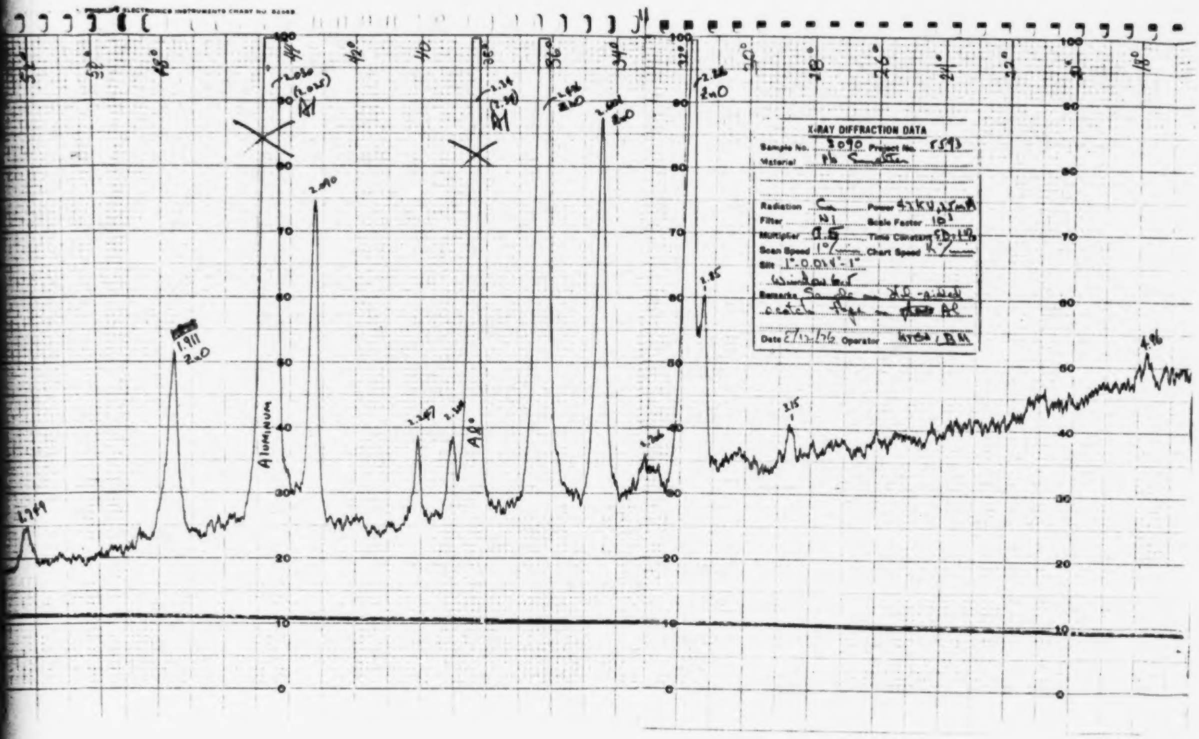
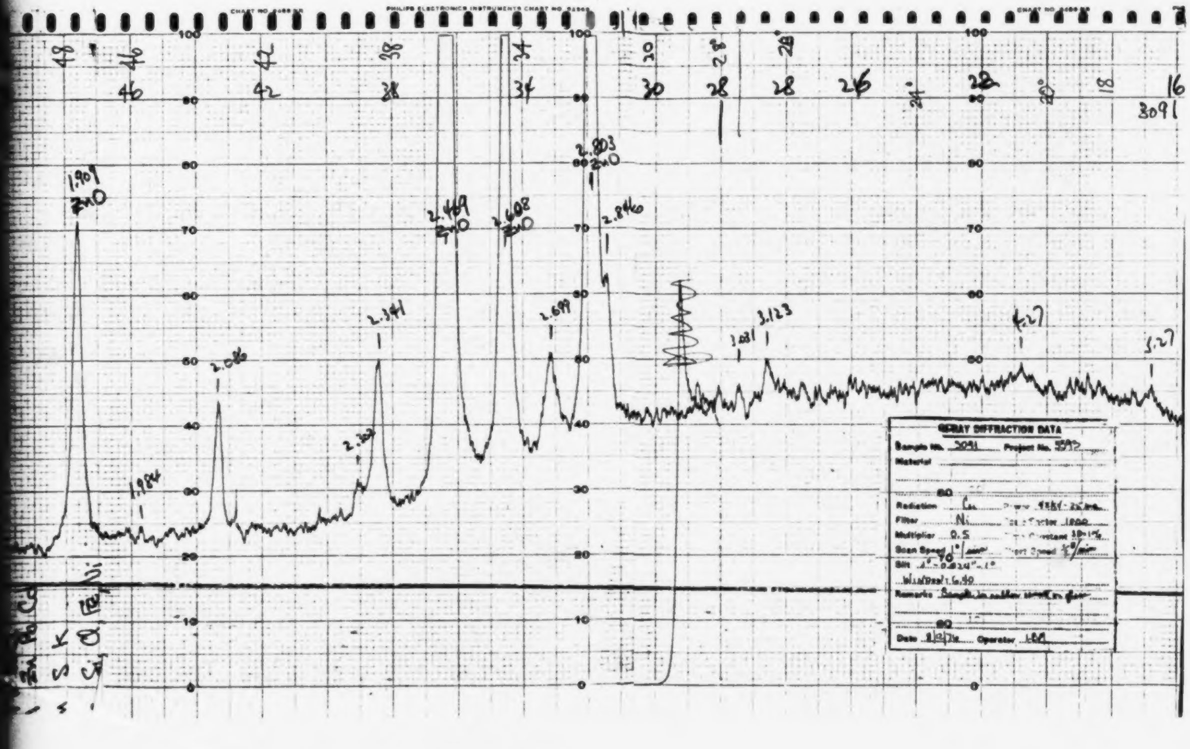


Figure G-64 - Run 33, Location 20, Filter 3091



G-63 - Run 33, Location 20, Filter 3090



G-64 - Run 33, Location 20, Filter 3091

APPENDIX H

ASARCO WEATHER STATION DATA, GLOVER, MISSOURI

7-7-76

Time	WD	WS MPH	Temp.	Barometer	S.P. OPERATING TIME (MIN.)
00-01	079	3.0	59.8	30.480	60
01-02	075	2.0	58.7	30.480	60
02-03	080	2.7	57.5	30.485	60
03-04	081	2.1	56.8	30.485	60
04-05	079	1.8	55.9	30.495	60
05-06	077	1.4	55.2	30.500	60
06-07	090	.2	57.1	30.500	60
07-08	182	.7	65.9	30.500	60
08-09	205	3.1	71.8	30.500	60
09-10	229	4.9	81.5	30.500	55
10-11	236	6.0	86.4	30.500	35
11-12	247	6.6	89.9	30.500	50
12-13	238	6.6	91.0	30.500	60
13-14	237	8.2	92.7	30.500	50
14-15	240	8.5	100.1	30.480	45
15-16	237	8.4	90.3	30.430	60
16-17	237	7.4	89.6	30.440	50
17-18	240	7.7	88.8	30.440	25
18-19	235	5.9	87.3	30.440	60
19-20	229	4.3	82.4	30.440	60
20-21	190	.8	74.7	30.440	45
21-22	083	.8	70.6	30.440	60
22-23	179	.3	67.8	30.440	45
23-00	074	1.7	65.9	30.440	60
					21 HR. 40 MIN.
AVG	229	2.9	74.7		

7-8-76

Time	WD	WS	Temp.	Barometer	S.P. OPERATING TIME (MIN.)
00-01	069	2.6	64.8	30.440	25
01-02	068	1.6	65.6	30.445	50
02-03	071	3.1	63.9	30.445	25
03-04	034	1.8	62.9	30.445	55
04-05	080	3.1	62.0	30.445	60
05-06	089	.9	61.4	30.445	30
06-07	074	1.4	63.8	30.445	60
07-08	199	.5	73.2	30.465	35
08-09	175	2.2	81.0	30.465	-0-
09-10	309	4.4	86.7	30.465	-0-
10-11	237	6.5	91.4	30.465	-0-
11-12	238	5.6	92.4	30.465	-0-
12-13	233	5.0	91.2	30.460	25
13-14	237	8.2	93.7	30.460	30
14-15	244	6.5	94.2	30.460	60
15-16	239	5.6	92.5	30.460	5
16-17	238	5.5	92.7	30.460	30
17-17	234	5.4	89.1	30.460	20
18-19	238	5.0	90.3	30.460	25
19-20	233	4.2	85.2	30.460	60
20-21	085	1.2	76.8	30.460	60
21-22	080	1.5	72.8	30.470	60
22-23	075	.8	70.3	30.475	60
23-00	074	2.3	68.7	30.480	40
					13 HR. 35 MIN.
AVG	160	$3^{\underline{5}}$	78^{2}		

7-9-76

Time	WD	WS	Temp.	Barometer	S.P. OPERATING TIME (MIN.)
00-01	074	2.0	67.2	30.490	55
01-02	076	2.0	65.9	30.490	60
02-03	076	1.3	64.4	30.490	60
03-04	078	2.0	63.4	30.490	60
04-05	081	2.2	62.2	30.490	60
05-06	080	1.8	61.4	30.495	40
06-07	079	.6	62.7	30.510	60
07-08	132	.2	70.2	30.520	60
08-09	176	1.1	79.2	30.530	60
09-10	228	3.0	86.8	30.530	60
10-11	231	4.8	91.2	30.540	60
11-12	228	6.1	92.0	30.545	30
12-13	210	6.4	91.1	30.545	-0-
13-14	209	8.7	91.3	30.540	-0-
14-15	219	9.5	91.4	30.530	-0-
15-16	217	9.3	91.0	30.505	-0-
16-17	234	8.4	90.9	30.510	30
17-18	225	8.4	90.7	30.535	-0-
18-19	228	6.1	88.9	30.490	15
19-20	226	4.4	85.0	30.480	50
20-21	080	.7	77.3	30.480	60
21-22	075	2.3	73.2	30.480	15
22-23	072	1.2	71.1	30.490	60
23-00	080	1.1	69.1	30.500	60
AVG	220	4.1	76.0		15 HR. 55 MIN.

July 12 1976

Time	WD	WS	Temp.	Barometer	S.P. Operating Time (min.)
00-01	194	.7	68.6	30.450	60
01-02	219	2.1	68.0	30.450	60
02-03	213	1.8	66.9	30.450	60
03-04	250	1.3	65.8	30.440	60
04-05	096	0.2	65.0	30.440	60
05-06	219	2.0	64.5	30.440	60
06-07	122	.7	68.2	30.440	60
07-08	347	5.5	81.0	30.440	60
08-09	337	5.7	84.3	30.440	50
09-10	320	3.7	90.0	30.440	40
10-11	335	4.8	93.2	30.430	45
11-12	316	5.9	93.7	30.430	10
12-13	335	5.2	93.5	30.430	60
13-14	327	5.8	93.5	30.410	60
14-15	331	5.5	95.4	30.400	60
15-16	312	5.2	94.7	30.400	60
16-17	305	4.2	95.6	30.360	40
17-18	289	3.9	95.2	30.340	-0-
18-19	Computer		88.3	30.340	-0-
19-20		Down		30.340	-0-
20-21	087	2.6	74.9	30.350	60
21-22	097	2.4	74.8	30.360	60
22-23	159	1.0	74.3	30.350	60
23-00	092	1.5	73.5	30.360	60
AVG	327	1.8	86.1		

July 13, 1976

Time	WD	WS	Temp.	Barometer	S.P. OPERATING TIME (MIN.)
00-01	071	1.2	71.8	30.380	60
01-02	154	1.3	70.3	30.410	55
02-03	212	2.8	69.7	30.410	45
03-04	189	0.9	68.8	30.420	60
04-05	194	.4	68.2	30.440	60
05-06	081	.6	68.4	30.445	60
06-07	084	1.2	70.8	30.445	55
07-08	179	.4	78.5	30.445	30
08-09	076	3.9	80.7	30.440	55
09-10	081	5.1	85.2	30.440	45
10-11	046	6.4	88.1	30.445	15
11-12	021	5.7	90.5	30.450	-0-
12-13	046	3.8	91.4	30.430	60
13-14	356	2.9	94.2	30.425	45
14-15	188	4.4	92.1	30.425	30
15-16	211	3.2	97.0	30.420	-0-
16-17	228	5.0	93.9	30.420	-0-
17-18	236	5.0	95.8	30.420	-0-
18-19	273	4.5	93.1	30.420	-0-
19-20	240	2.2	87.8	30.400	55
20-21	077	1.4	80.5	30.400	60
21-22	086	1.4	77.1	30.400	60
22-23	081	2.7	75.0	30.400	60
23-00	076	2.2	73.1	30.400	60
AVG	126	.5	83.6		

July 14, 1972

Time	WD	WS	Temp.	Barometer	S.P. OPERATING TIME (MIN.)
00-01	83	1.4	71.7	30.400	60
01-02	77	2.1	70.5	30.400	60
02-03	80	2.1	69.4	30.400	45
03-04	80	0.6	68.6	30.400	60
04-05	– Computer	–	–	30.400	60
05-06	–	–	–	30.400	60
06-07	–	Down –	–	30.400	60
07-08	167	0.7	76.2	30.420	-0-
08-09	203	1.7	82.8	30.420	-0-
09-10	218	4.5	90.4	30.420	-0-
10-11	236	6.5	95.2	30.460	-0-
11-12	233	5.0	97.3	30.460	20
12-13	237	5.3	97.7	30.460	-0-
13-14	236	5.5	99.1	30.440	-0-
14-15	233	7.0	101.0	30.420	5
15-16	246	4.8	95.3	30.420	50
16-17	237	6.4	95.1	30.420	60
17-18	76	3.3	98.4	30.420	60
18-19	58	3.9	87.1	30.420	60
19-20	83	1.6	85.5	30.420	60
20-21	77	1.7	80.4	30.420	60
21-22	76	1.7	77.8	30.430	60
22-23	80	1.5	75.9	30.445	-0-
23-00	120	0.4	74.3	30.445	-0-
AVG	224	1.6	85.1		

July 15 1976

Time	WD	WS	Temp.	Barometer	S.P. OPERATING TIME (MIN.)
00-01	194	.7	72.9	30.445	-0-
01-02	137	.8	72.0	30.445	-0-
02-03	148	1.0	71.0	30.445	-0-
03-04	211	1.9	70.6	30.445	-0-
04-05	206	1.3	70.7	30.445	-0-
05-06	115	.9	70.3	30.450	-0-
06-07	227	1.6	70.9	30.470	-0-
07-08	223	2.4	75.1	30.490	-0-
08-09	231	2.7	78.0	30.490	-0-
09-10	307	2.4	82.4	30.495	-0-
10-11	242	5.1	84.4	30.500	-0-
11-12	292	4.6	90.5	30.505	-0-
12-13					
13-14					-0-
14-15					
15-16					
16-17					
17-18					
18-19					
19-20					
20-21					
21-22					
22-23					
23-00					

APPENDIX I

ASARCO WEATHER STATION DATA, EAST HELENA, MONTANA

There were several ASARCO weather stations at the East Helena, Montana, plant. The data contained in this appendix are those taken at the Zinc Stack weather station.

BAROMETRIC PRESSURE - HELENA, MONTANA
(in millibars and inches of mercury)

Date	Bar. Pressure in Millibars	Bar. Pressure in in. Hg (sea level)	Helena (3,828 ft above sea level)
7-22-76	1,015.3	29.98	26.07
7-23-76	1,017.0	30.03	26.12
7-24-76	1,018.9	30.09	26.18
7-25-76	-	-	-
7-26-76	1,009.4	29.81	25.90
7-27-76	1,014.4	29.96	26.05
7-28-76	1,010.8	29.85	25.94
7-29-76	1,008.3	29.78	25.87

WIND DIRECTION - ASARCO - TAKEN AT ZINC STACK, EAST HELENA

Hour	7-22-76		7-23-76		7-24-76		7-25-76		7-26-76		7-27-76		7-28-76		7-29-76		7-30-76	
00	290	240	220	210	240	280	265	265	215	200	205	205	280	230	185	190	335	330
01	220	270	220	210	300	330	230	245	220	220	205	215	240	250	200 300	310 210	325	330
02	300	230	220	230	170	090 180	265	265	205	195	200	220	310	230	200	215	325	320
03	280	310	220	225	060 170	195	270	295	200	195	300	305	215	235	230	240	310	310
04	310	310	230	260	215	220	330	310	185	225	290	290	230	210	230	240	315	320
05	215	195	270	210	220	230	300 130	135	220	200	280	285	215	250	230	240	315	300
06	200	200	220 360	215	270	300	145	205	185	170	285	280	220	210	190	170	300	290
07	210 300	280	190	180	210	205	285	220	180 310	320	270	290	230	230	170 260	310	280	265
08	280	050	195	150	210	240	215	180	VAR	130 340	290	285	220	230	310	300	300	315
09	060	060	020	040	280	290	190 050	015	315	310	290	295	180	100	320	335	325	330
10	020	090	010	345	270	320	045	040	305	305	280	275	090	060	345	330	330	350
11	050	020	345	020	355	330	350	330	330	360	280	265	320	040	330	350	340	345
12	020	200	040	110	335	340	330	310	310	350	275	275	325 175	150 310	020	360	360	020
13	010	040	110	110	350	005	340	010	310	300	275	280	310	300	010	030	030	010
14	020	010	115	120	350 280	280	010	VWD	280	280	275	260	300	300	030	030 090	010	010

WIND DIRECTION - ASARCO - TAKEN AT ZINC STACK, EAST HELENA (Concluded)

Hour	7-22-76		7-23-76		7-24-76		7-25-76		7-26-76		7-27-76		7-28-76		7-29-76	
15	310	300	120	120	285	275	335	340	290	300	265	270	280	280	030	080
		120														
16	140	130	115	130	305.	325	360	360	300	310	265	270	290	290	120	140
17	120	020	120	120	315	305	350	340	290	300	265	265	285	290	150	160
18	280	020	120	130	305	265	360	020	290	280	270	280	290	300	175	160
19	340	340	130	130	270	275	VAR	130	280	280	285	285	290	305	170	010
															010	
20	320	350	135	140	275	265	120	140	280	270	280	295	315	300	205	230
21	350	350	150	170	265	265	140	130	270	270	315	310	330	340	350	330
22	340	330	175	200	275	255	160	190	265	230	310	305	335	310	330	325
23	315	270	220	230	230	260	200	210	230	210	240	270	310	180	330	335
													140			

WIND SPEED (MPH) - ASARCO - TAKEN AT ZINC STACK, EAST HELENA

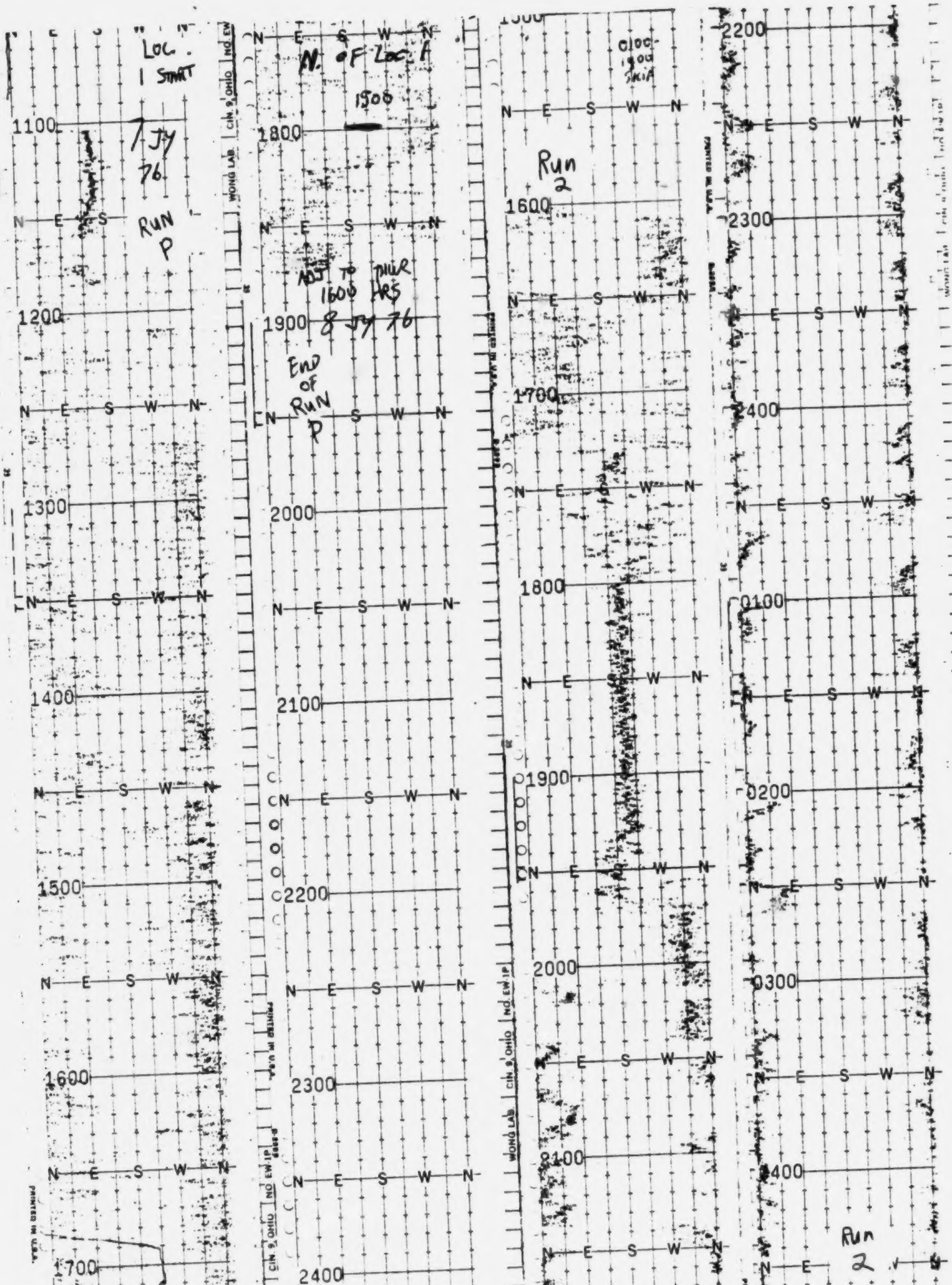
Hour	7-22-76		7-23-76		7-24-76		7-25-76		7-26-76		7-27-76		7-28-76		7-29-76		7-30-76	
00	6.0	7.5	7.5	12.0	6.5	4.0	12.5	15.0	10.5	10.5	17.0	18.0	6.0	8.0	10.0	9.0	16.0	17.0
01	10.0	5.0	9.0	10.0	12.0	7.0	13.0	13.5	10.0	9.5	18.0	13.0	9.0	9.0	10.0	5.0	15.0	13.0
02	4.5	3.0	7.0	6.0	5.0	1.0	15.0	16.0	10.0	9.5	20.0	14.0	5.0	3.0	9.0	9.0	12.0	9.0
03	4.5	5.0	3.5	3.0	2.0	8.0	11.0	7.5	9.5	8.5	8.0	9.0	3.0	9.0	6.0	4.0	9.0	12.0
04	5.5	4.0	3.0	3.5	7.0	7.0	5.0	5.0	6.5	6.0	10.0	16.0	9.0	14.0	5.0	4.0	11.5	11.0
05	5.5	10.0	2.5	3.0	6.0	6.0	2.0	4.0	8.0	7.5	16.0	15.5	15.0	9.0	6.0	5.0	9.0	8.0
06	11.0	12.0	3.0	4.0	4.0	4.5	7.0	5.5	4.5	4.5	12.0	15.0	10.0	13.0	10.0	7.0	7.0	8.0
07	7.0	3.5	3.0	1.5	6.0	9.0	5.0	3.0	4.0	3.0	12.0	13.0	10.0	6.0	5.0	4.5	10.0	7.0
08	3.0	3.0	8.0	3.0	8.0	6.0	4.5	3.5	2.0	3.0	21.0	15.5	5.0	3.0	6.5	4.0	7.5	6.0
09	3.5	2.5	2.0	4.0	4.0	4.5	2.5	2.5	3.5	4.0	13.0	20.0	2.0	3.0	3.5	6.0	6.5	6.5
10	3.0	5.0	6.5	9.0	5.0	4.0	5.0	4.0	4.0	3.5	21.0	22.0	4.0	4.0	5.0	3.5	6.5	7.0
11	4.0	4.0		4.0	7.0	6.0	3.5	4.5	5.0	4.5	20.0	26.0	3.5	2.5	5.0	3.5	6.0	5.0
12	4.0	6.0	5.0	7.0	8.0	8.0	6.0	4.5	3.5	3.5	23.0	23.0	6.0	7.0	5.0	5.0	4.0	3.0
13	6.0	7.0	8.0	10.0	11.0	12.0	4.0	6.5	8.0	9.5	23.0	21.0	11.0	11.0	7.5	7.0	6.5	8.0
14	7.0	6.0	13.0	13.0	15.0	22.0	8.0	5.5	17.0	17.0	21.0	19.0	17.0	18.0	10.0	10.0	6.0	6.0
15	6.0	5.0	13.0	15.0	24.0	33.5	4.5	4.5	15.5	17.0	19.0	18.0	18.0	15.0	8.0	7.0		
16	5.0	5.5	17.0	20.0	10.0	13.5	5.5	6.0	14.0	15.0	19.0	14.0	23.5	21.0	10.0	10.0		
17	5.5	8.0	23.0	23.0	11.0	18.5	7.0	9.0	14.0	18.0	20.0	18.0	21.0	18.0	9.0	10.0		
18	4.5	5.0	23.0	23.0	15.0	31.5	8.0	8.0	16.0	14.0	18.0	18.0	16.0	16.0	10.0	6.0		
19	6.5	11.0	21.0	23.0	33.0	25.0	7.0	11.0	10.0	14.0	19.0	17.0	15.0	15.0	11.0	19.0		
								29.0										
20	12.0	14.0	21.0	18.0	22.0	23.5	10.0	12.0	25.0	26.0	15.0	15.0	14.5	15.0	16.0	10.0		
21	17.0	13.5	16.5	11.0	20.0	21.5	16.5	15.0	22.0	18.0	13.5	15.5	13.5	16.5	11.0	19.0		
22	10.0	8.5	7.5	8.0	16.5	12.5	10.0	11.0	16.0	12.0	12.0	11.0	14.0	8.0	20.0	19.0		
23	9.0	8.0	7.0	4.5	13.0	14.0	17.5	10.0	12.0	15.0	7.0	7.0	6.5	6.5	17.0	20.0		

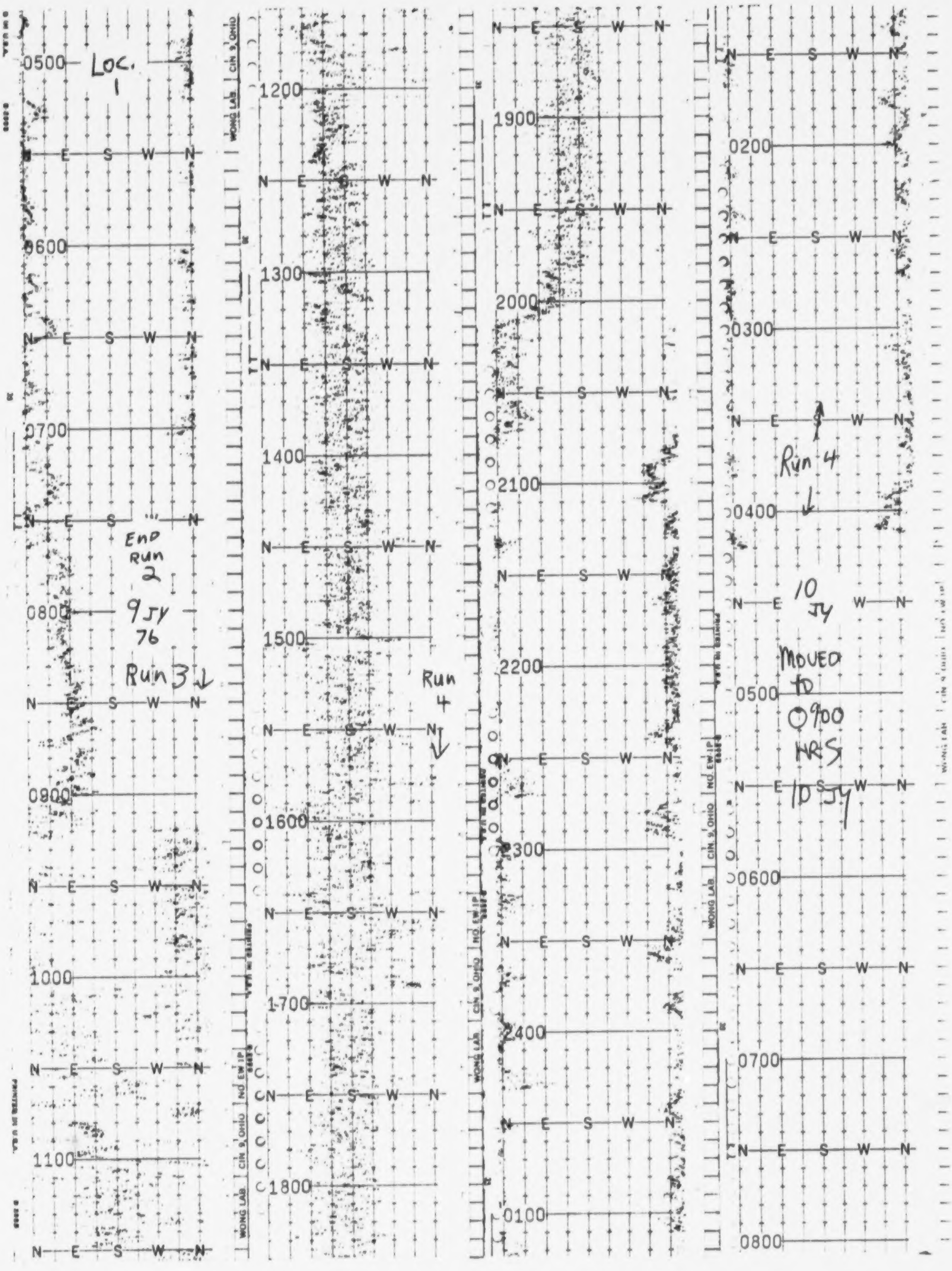
TEMPERATURE (°C) - ASARCO - TAKEN ON THE GROUND
AT THE ZINC STACK, EAST HELENA

Hour	7-22-76		7-23-76		7-24-76		7-25-76		7-26-76		7-27-76		7-28-76		7-29-76		7-30-76	
00	16.6	16.9	19.3	19.4	22.2	23.2	15.1	15.7	20.0	15.9	22.1	20.5	14.8	14.7	16.5	16.0	17.5	16.9
01	16.8	16.0	18.7	18.1	23.3	21.3	15.1	14.9	17.9	18.1	20.9	20.2	14.1	14.0	15.7	14.5	16.1	15.6
02	16.0	14.9	16.9	16.3	21.9	21.2	15.0	14.3	17.7	15.1	19.9	18.7	12.8	12.2	14.7	13.2	15.2	14.6
03	15.0	13.9	16.1	15.9	20.1	19.9	13.9	14.4	15.0	14.1	20.1	18.5	11.9	12.6	14.2	12.8	14.4	14.1
04	13.6	12.4	15.6	15.4	19.7	18.2	12.8	12.0	13.2	13.2	17.6	18.1	12.3	11.7	12.4	11.9	14.0	13.6
05	12.7	12.5	14.7	14.2	19.0	17.7	11.7	11.4	12.8	12.5	22.4	20.6	11.0	11.2	11.9	10.3	13.1	12.0
06	11.8	11.1	13.2	12.9	12.7	18.1	10.8	10.9	12.5	11.9	20.3	20.2	10.4	9.4	10.9	11.1	12.1	12.1
07	12.3	12.2	14.4	14.3	17.8	19.0	11.5	12.8	12.5	13.7	19.9	20.4	10.1	11.8	10.2	11.3	12.7	13.2
08	14.6	16.7	15.8	17.0	20.1	21.3	14.0	15.6	14.0	15.2	20.8	21.2	11.8	12.3	12.6	12.9	14.3	14.8
09	16.9	17.8	17.3	18.5	21.6	21.9	16.4	17.3	15.6	17.3	21.2	21.6	14.3	17.3	14.2	15.6	15.1	15.7
10	18.8	19.9	20.3	20.6	23.4	24.7	18.2	18.7	19.0	20.3	22.0	22.2	19.0	19.3	16.8	18.0	16.6	17.5
11	21.8	21.9	21.6	23.8	26.3	27.0	19.7	20.3	21.6	23.1	22.4	22.8	20.3	21.4	19.7	20.9	17.8	18.0
12	22.7	23.9	27.8	30.9	27.4	27.4	21.6	22.2	25.0	26.5	23.5	23.3	22.7	24.2	22.6	24.5	19.2	21.3
13	25.0	27.3	31.1	33.7	27.4	29.2	22.9	23.8	27.7	30.5	24.2	24.4	24.8	25.9	25.6	27.7	22.5	23.0
14	27.5	27.4	34.1	34.7	29.9	26.3	24.3	25.5	30.2	30.8	24.8	25.9	26.4	27.0	28.6	31.4	22.1	24.6
15	27.8	29.7	35.0	35.0	23.2	19.4	25.8	25.9	30.7	30.9	25.8	25.5	27.1	27.6	30.7	30.1		
16	29.7	29.8	36.1	34.4	21.2	21.4	26.5	27.3	31.4	31.6	26.2	26.1	27.7	28.1	30.8	30.5		
17	30.4	29.0	35.7	35.2	21.8	21.9	27.1	27.3	32.0	31.9	26.2	26.7	28.6	28.4	29.4	28.7		
18	29.3	29.6	35.2	35.2	21.3	19.1	28.6	27.7	31.9	31.6	26.2	26.4	28.5	28.6	29.7	29.4		
19	29.7	29.3	34.8	34.1	19.4	19.6	28.5	28.5	31.7	30.7	25.7	25.5	28.7	28.0	28.3	26.7		
20	28.9	27.3	32.2	30.2	18.4	17.7	27.3	26.9	28.6	28.3	24.9	23.7	26.9	25.7	25.2	25.6		
21	24.3	24.1	28.0	27.7	17.4	17.2	25.3	23.2	27.7	26.5	21.4	20.4	23.8	22.2	22.6	20.9		
22	22.8	20.6	27.5	25.5	16.7	16.0	21.3	20.7	25.7	25.7	19.5	16.3	21.4	18.6	19.8	18.7		
23	21.1	19.9	25.7	23.0	16.3	15.2	20.2	19.8	23.6	22.1	16.0	15.7	15.8	17.3	18.4	18.0		

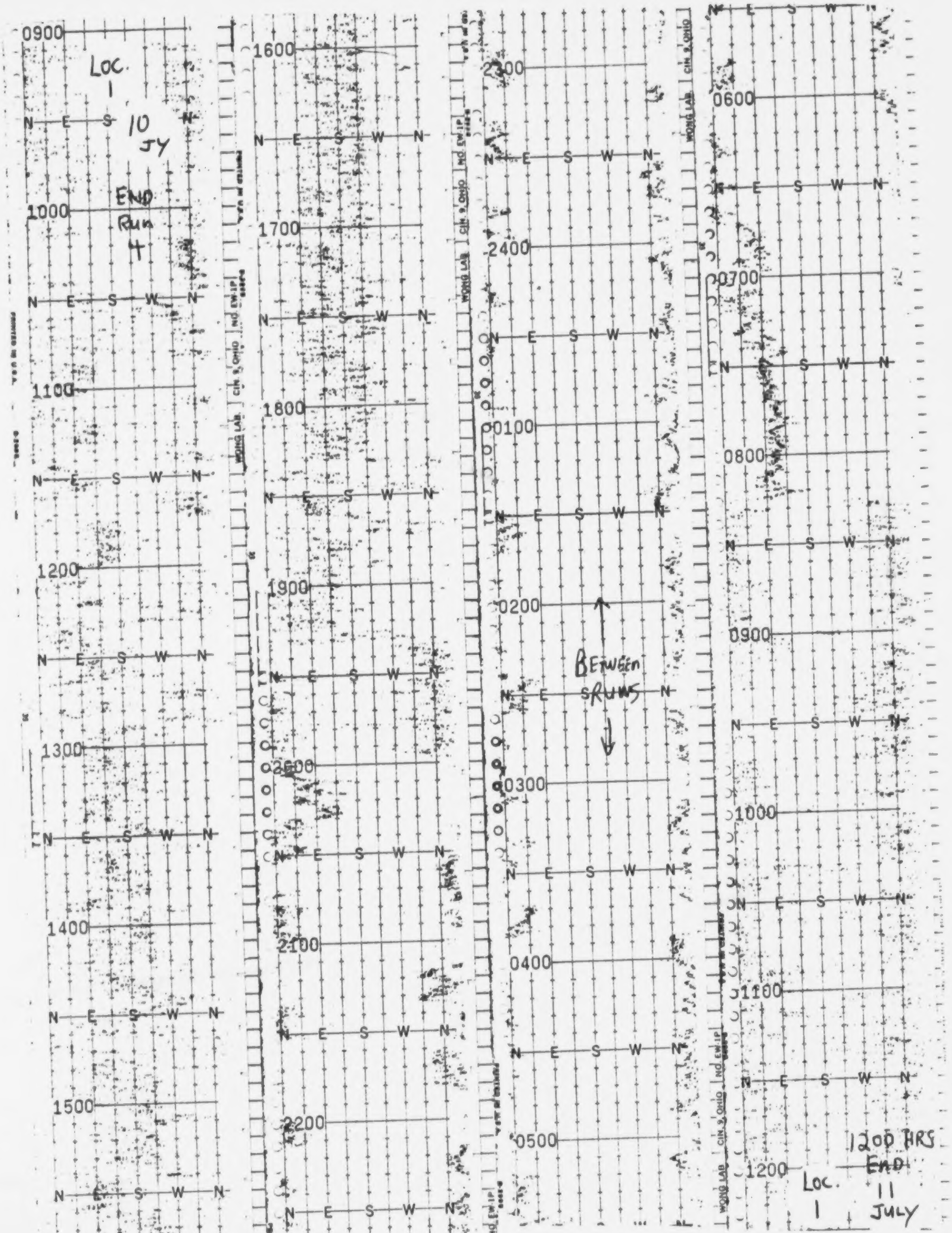
APPENDIX J

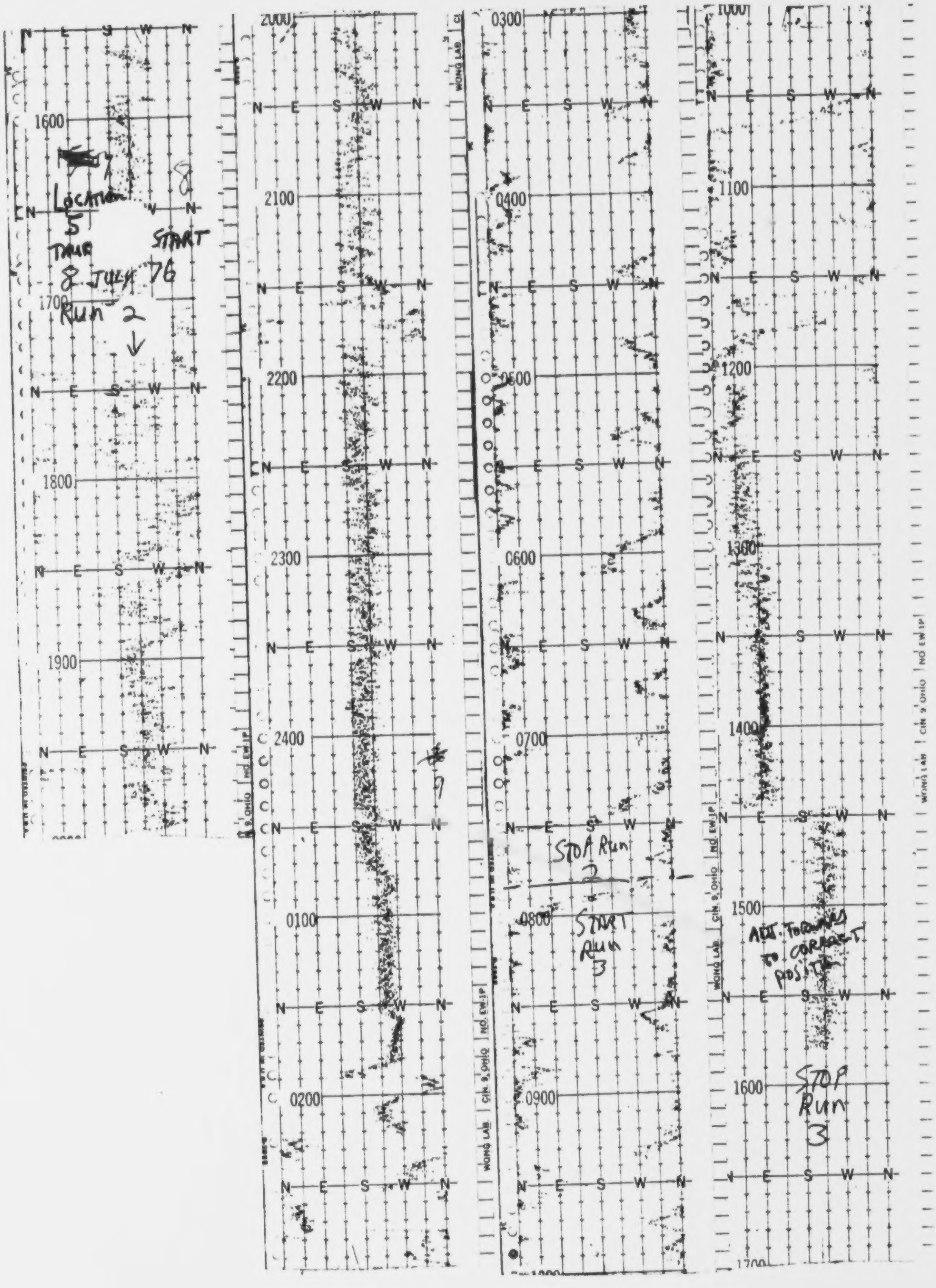
CHARTS FROM MRI ON-SITE METEOROLOGICAL STATIONS

Loc. 1 Start
7 Jy 76
Run P
N. of Loc. 1
1500
Adj to thur 1600 hrs 8 Jy 76
End of Run P
Run 2
0100-1900 skip
Run 2
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
N E S W N
WONG LAB CIN 9, OHIO NO EW IP
PRINTED IN U.S.A.



0500
Loc. 1
N E S W N
0600
0700
End Run 2
0800
9 JY 76
Run 3
0900
1000
1100
1200
1300
1400
1500
Run 4
1600
1700
1800
WONG LAB CIN 9, OHIO
1900
2000
2100
2200
2300
2400
0100
0200
0300
Run 4
0400
10 JY
Moved to 0900 HRS 10 JY
0500
0600
0700
0800


LOC. 1
10 JY
END Run 4
0900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
N E S W N
BETWEEN RUNS
WONG LAB. CIN 3, OHIO
1200 HRS END
LOC. 1
11 JULY



Location 5
TAUR
START
8 JULY 76
Run 2
↓

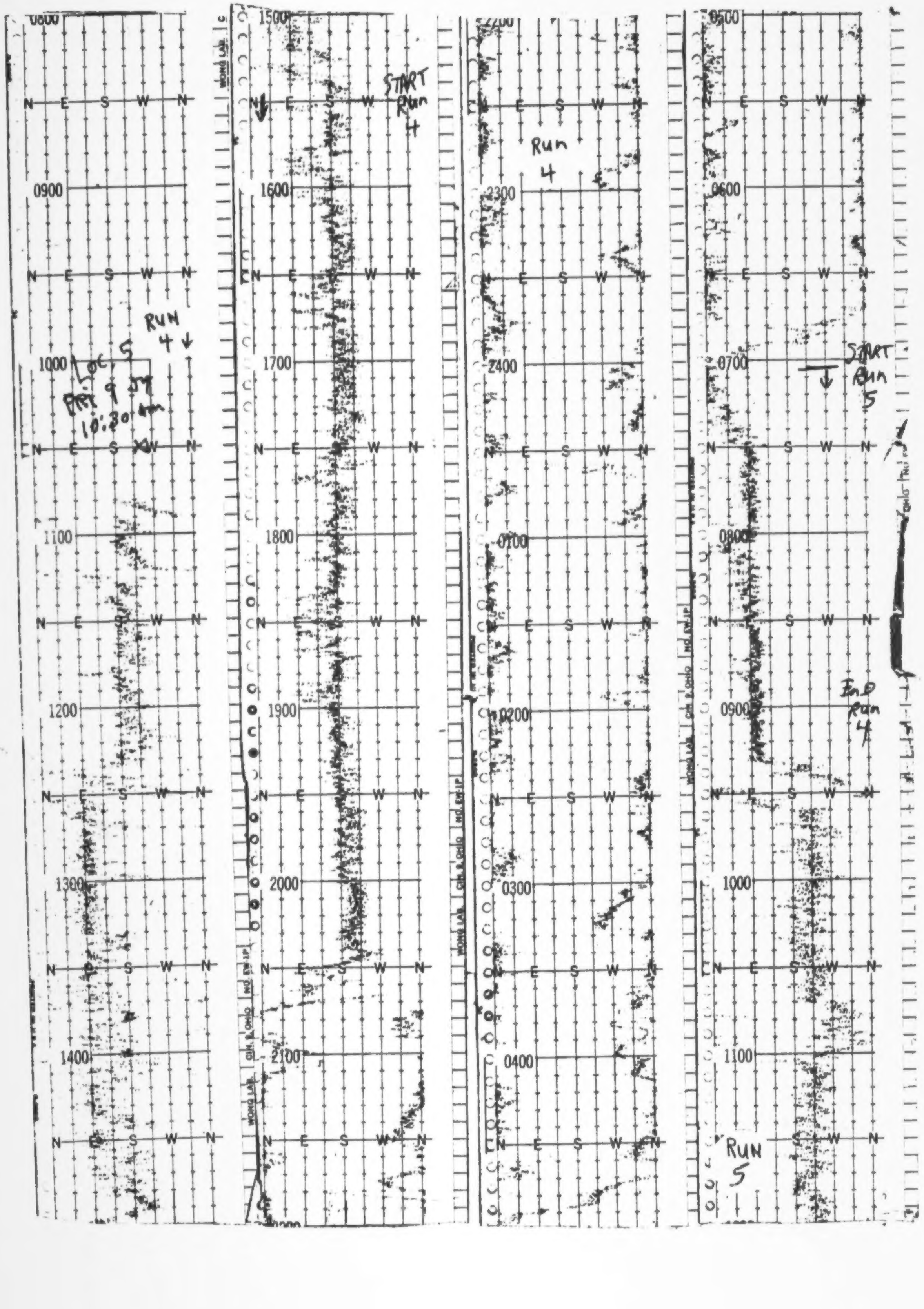
8

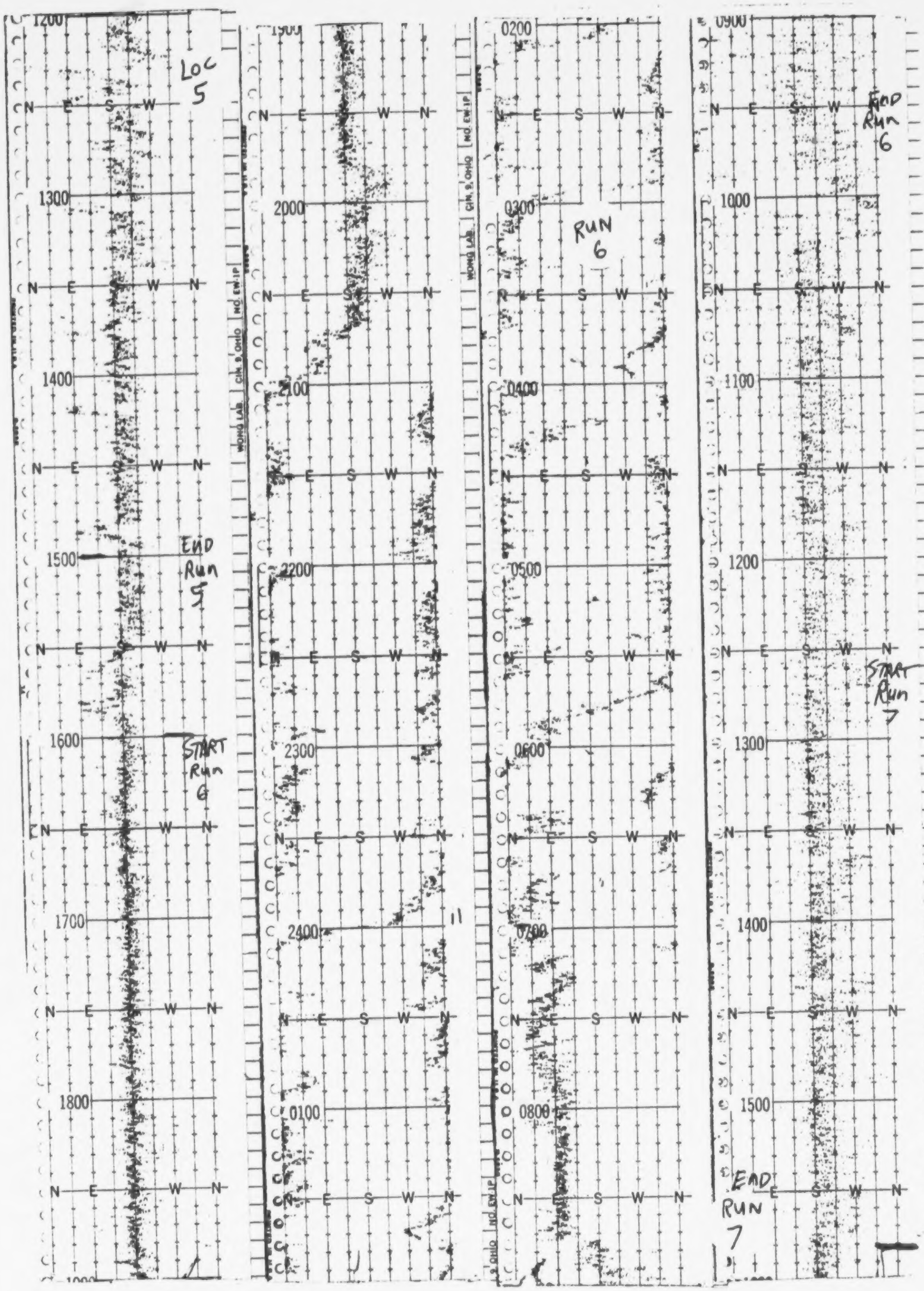
#9

STOP Run 2
START Run 3

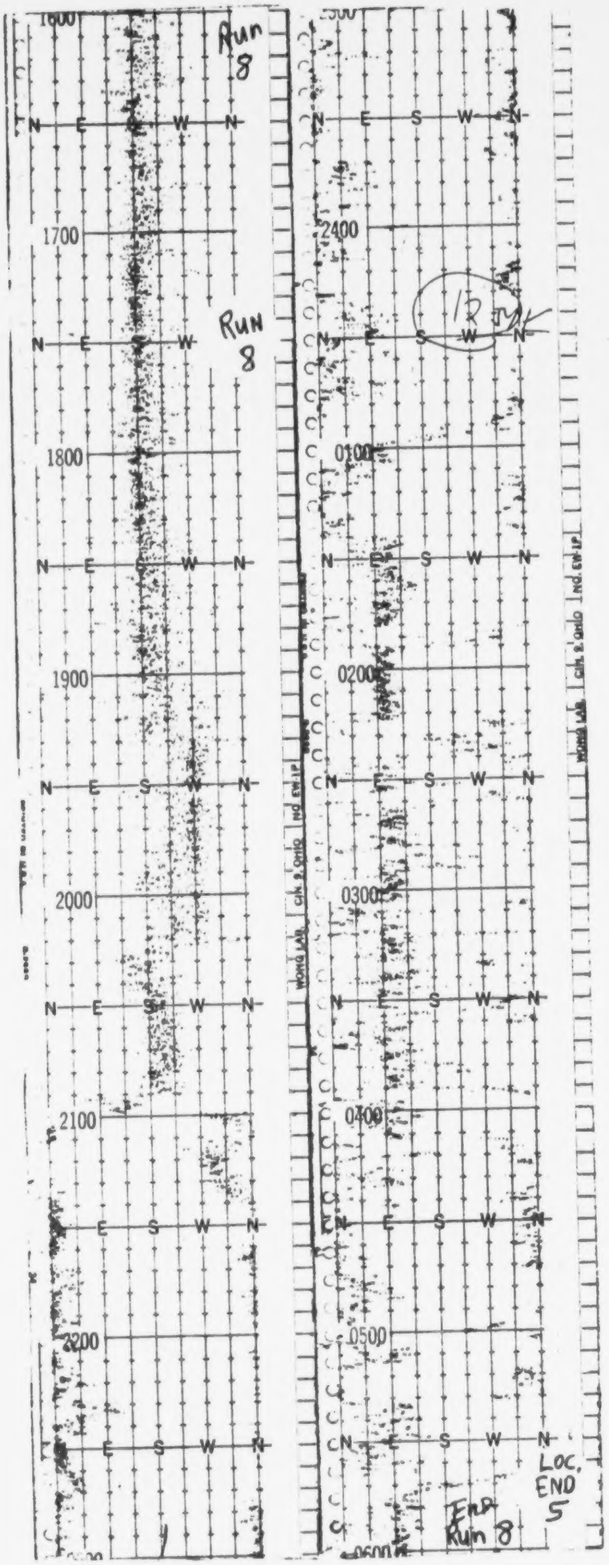
ADJ. TOWARDS TO CORRECT POSITION

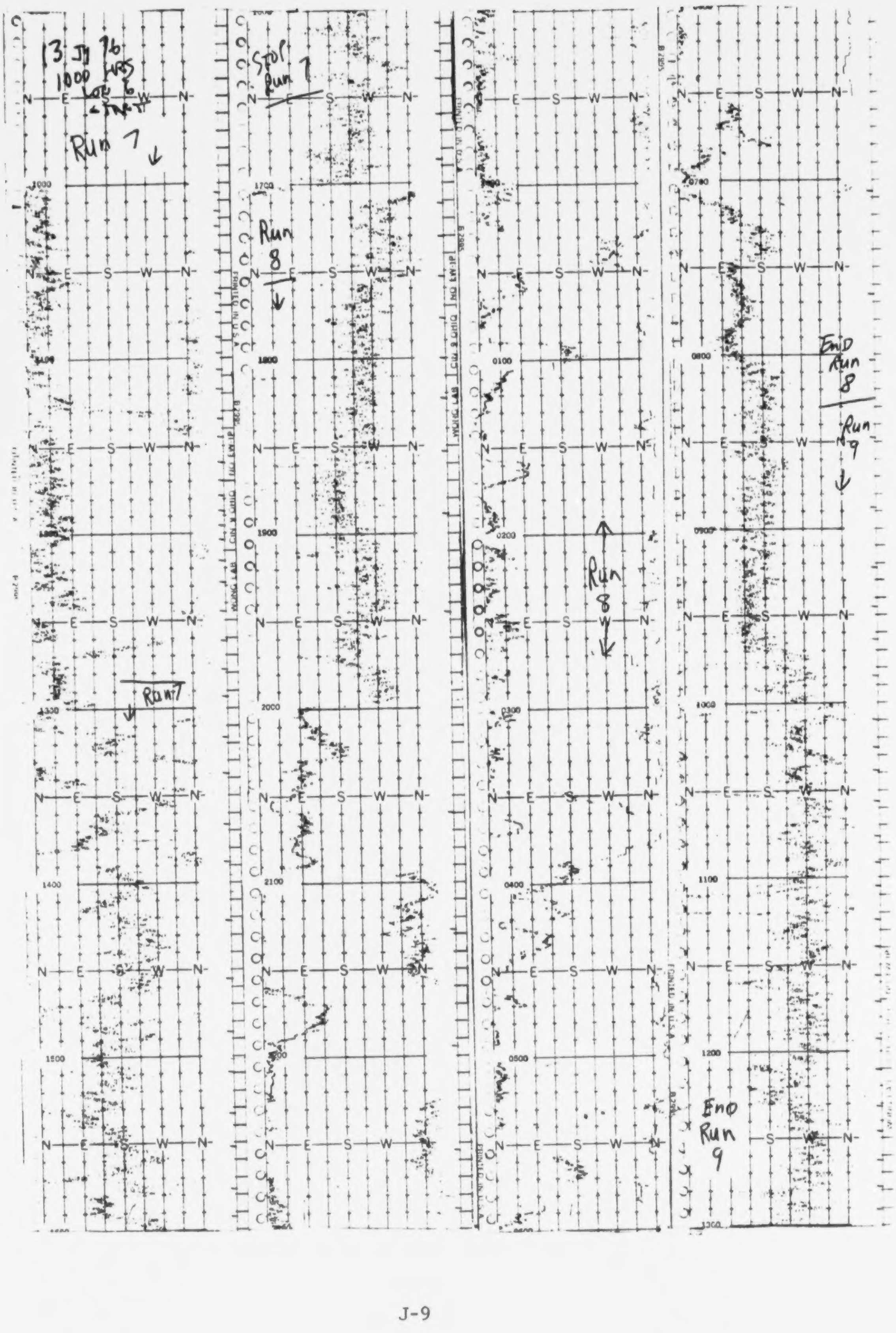
STOP Run 3

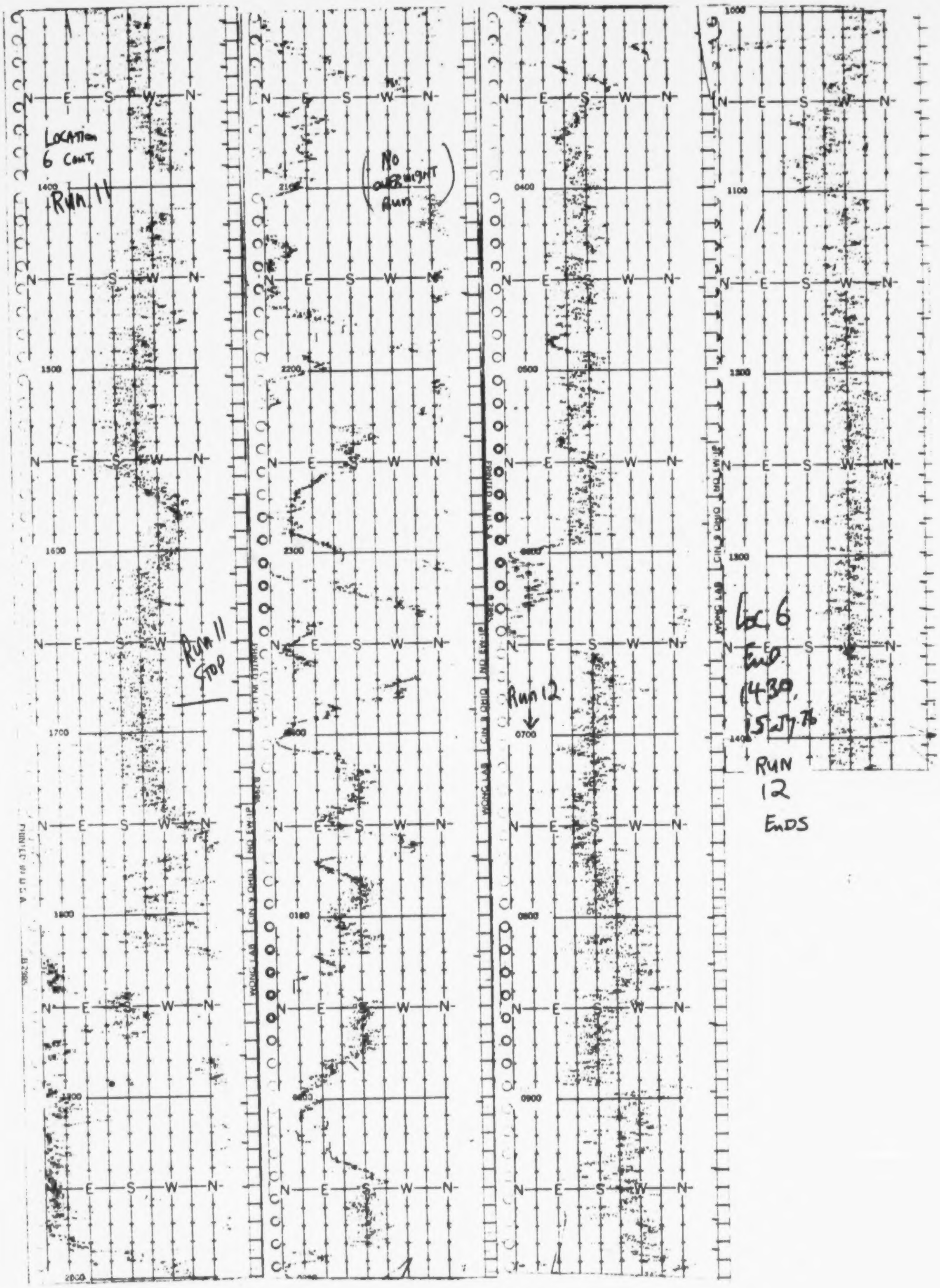

RUN 4 ↓
Loc 5
APR 9 79
10:30 Am
START Run 4
Run 4
START Run 5
End Run 4
RUN 5
0800
0900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
N E S W N

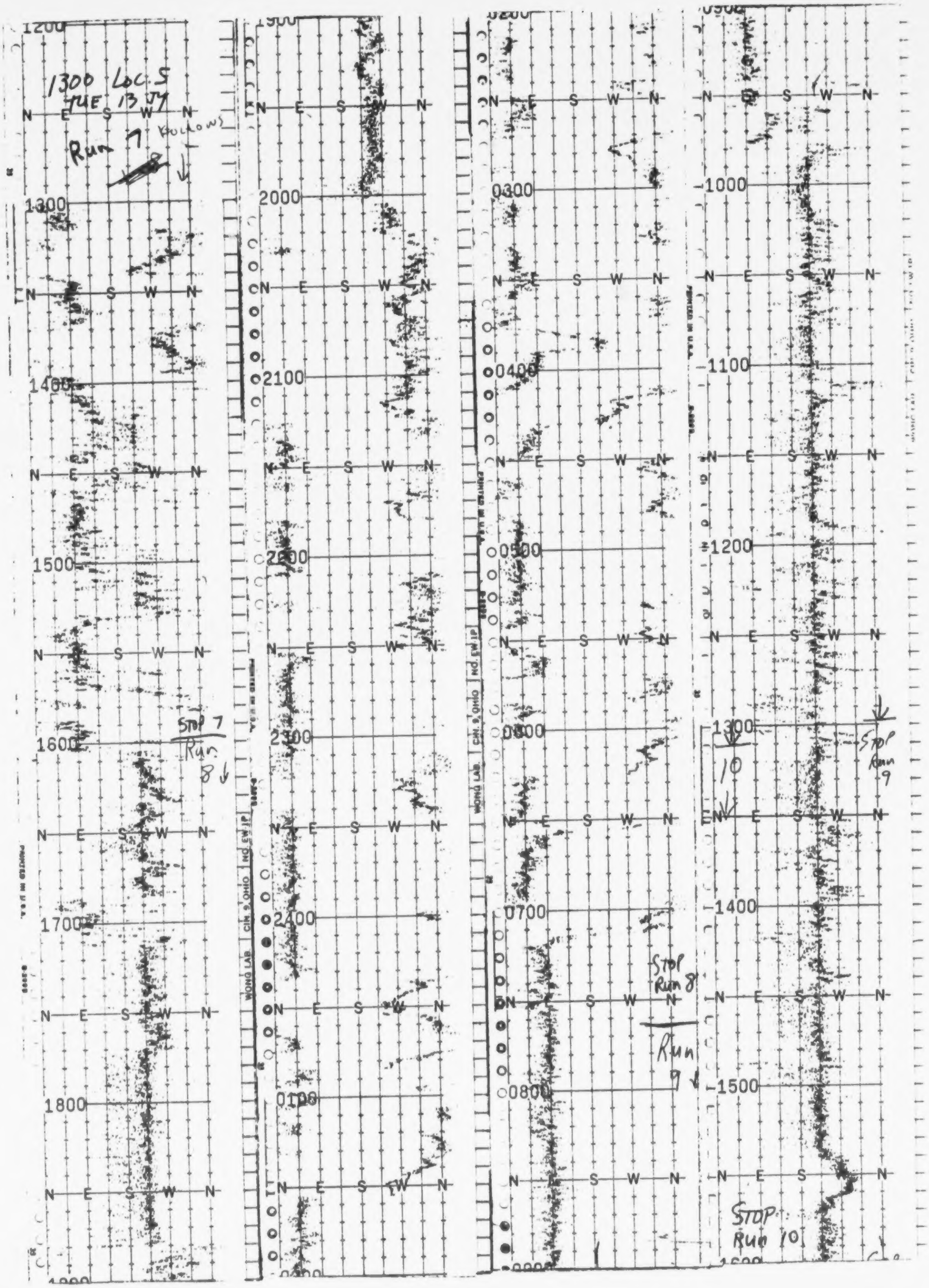


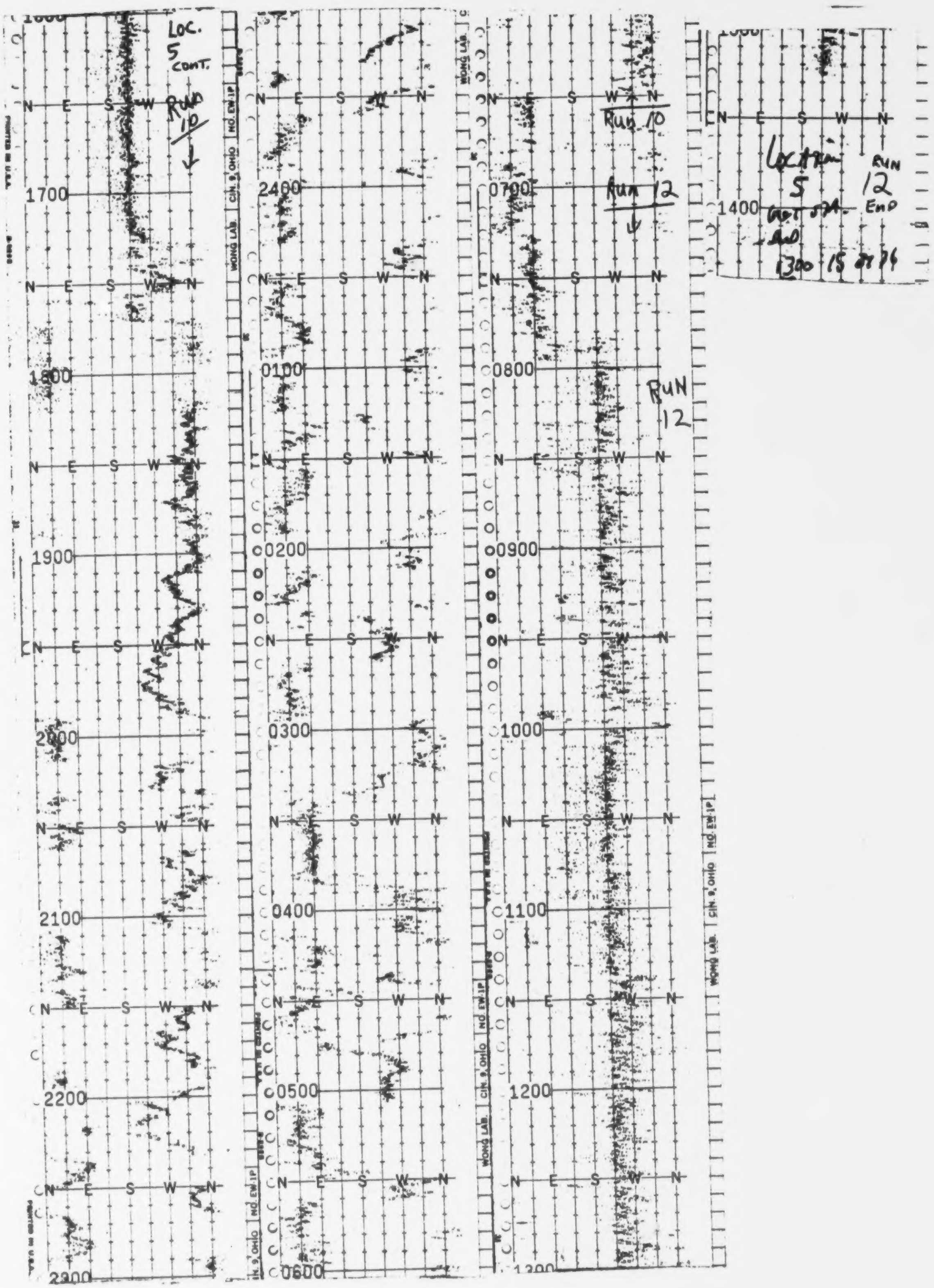
Loc 5
1200
1300
1400
1500
End Run 5
1600
Start Run 6
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
Run 6
0400
0500
0600
0700
0800
0900
End Run 6
1000
1100
1200
Start Run 7
1300
1400
1500
End Run 7
N
E
S
W
N
WONG LAB.
CIN. 9, OHIO
NO. EW 1P

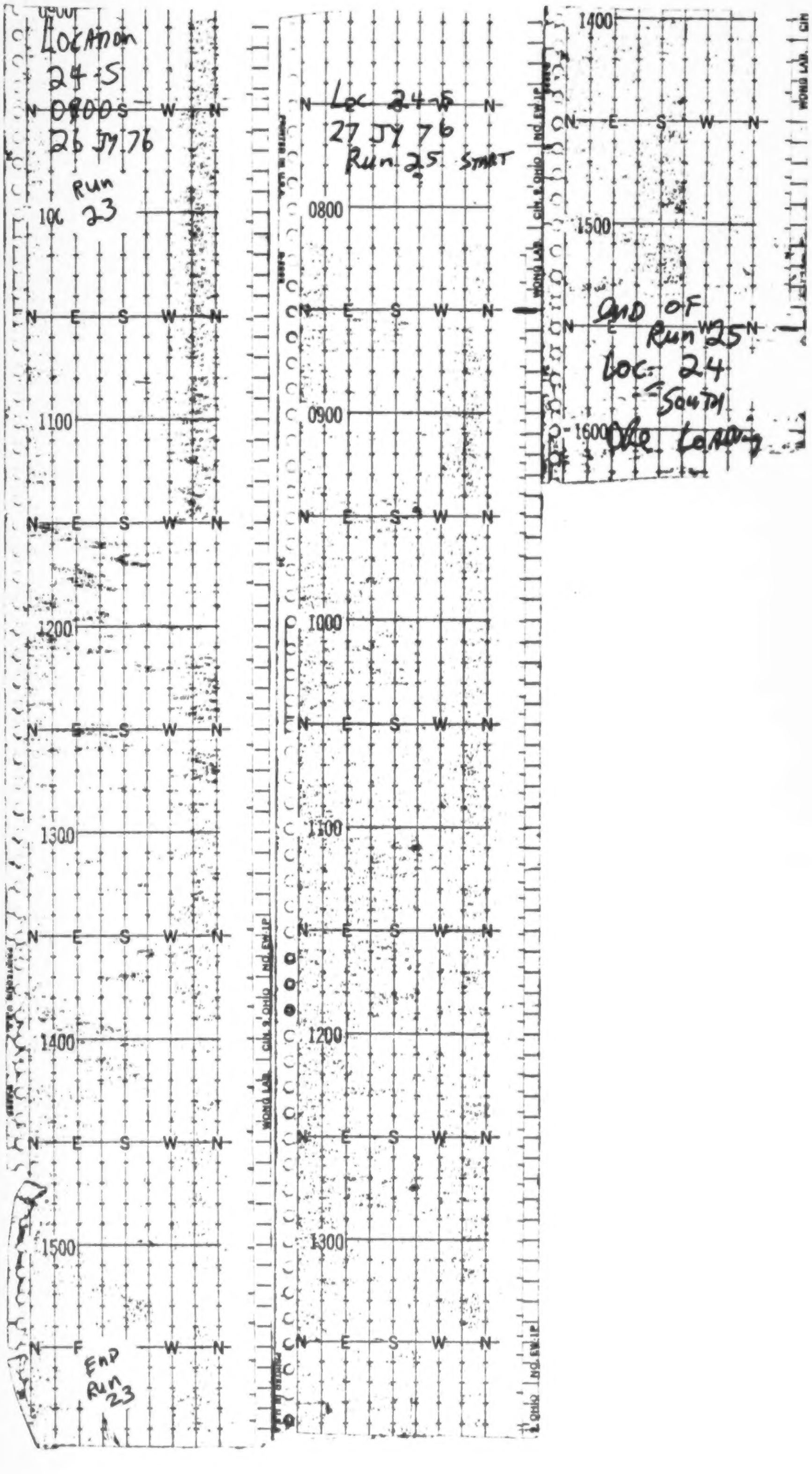

1600
Run 8
N E S W N
1700
RUN 8
1800
1900
2000
2100
2200
2300
2400
12 m
0100
0200
0300
0400
0500
0600
LOC. END 5
End Run 8
WONG LAB. CIN. 8 OHIO NO. EW-1P


13 Jy 76
1000 HRS
Loc 6
Run 7
Run 7
Stop Run 7
Run 8
Run 8
End Run 8
Run 9
End Run 9
N
E
S
W
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300


Location 6 Cont.
Run 11
Run 11 Stop
(No overnight Run)
Run 12
Loc 6 End 1430, 15 Jy 76
Run 12 Ends
N E S W N
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
0100
0200
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300
1400


1300 LOC 5
TUE 13 JY
Run 7 follows
STOP 7
Run 8
STOP Run 8
Run 9
STOP Run 9
10
STOP Run 10
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0300
0400
0500
0600
0700
0800
1000
1100
1200
1300
1400
1500
N E S W N
WONG LAB CIN. 9, OHIO NO. EW 1P
PRINTED IN U.S.A.


LOC. 5 CONT.
RUN 10
Run 10
Run 12
RUN 12
Location 5
RUN 12 END
1300 15
N E S W N
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300
1400
WONG LAB.
CIN. 9, OHIO
NO. EW-1P
PRINTED IN U.S.A.

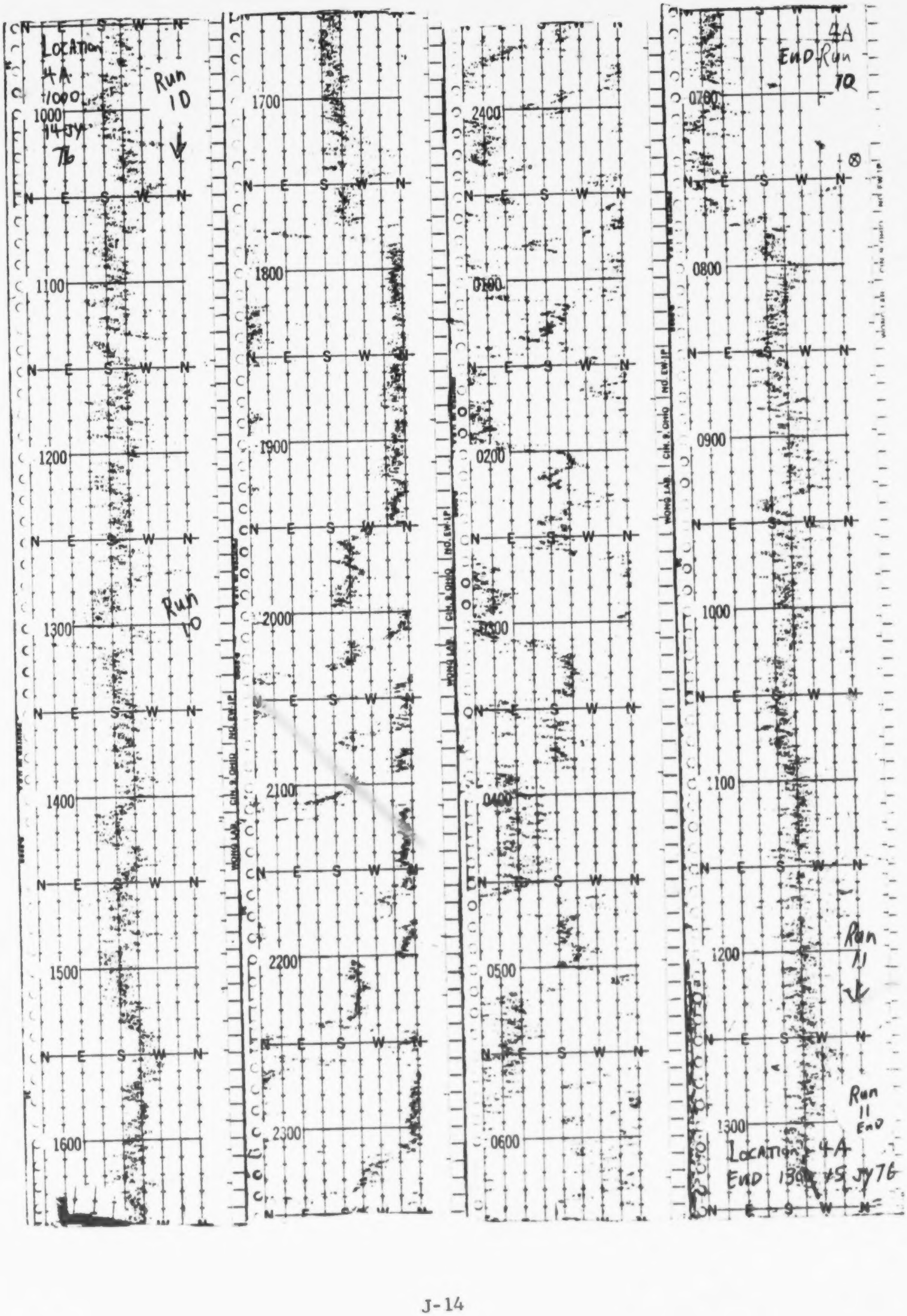


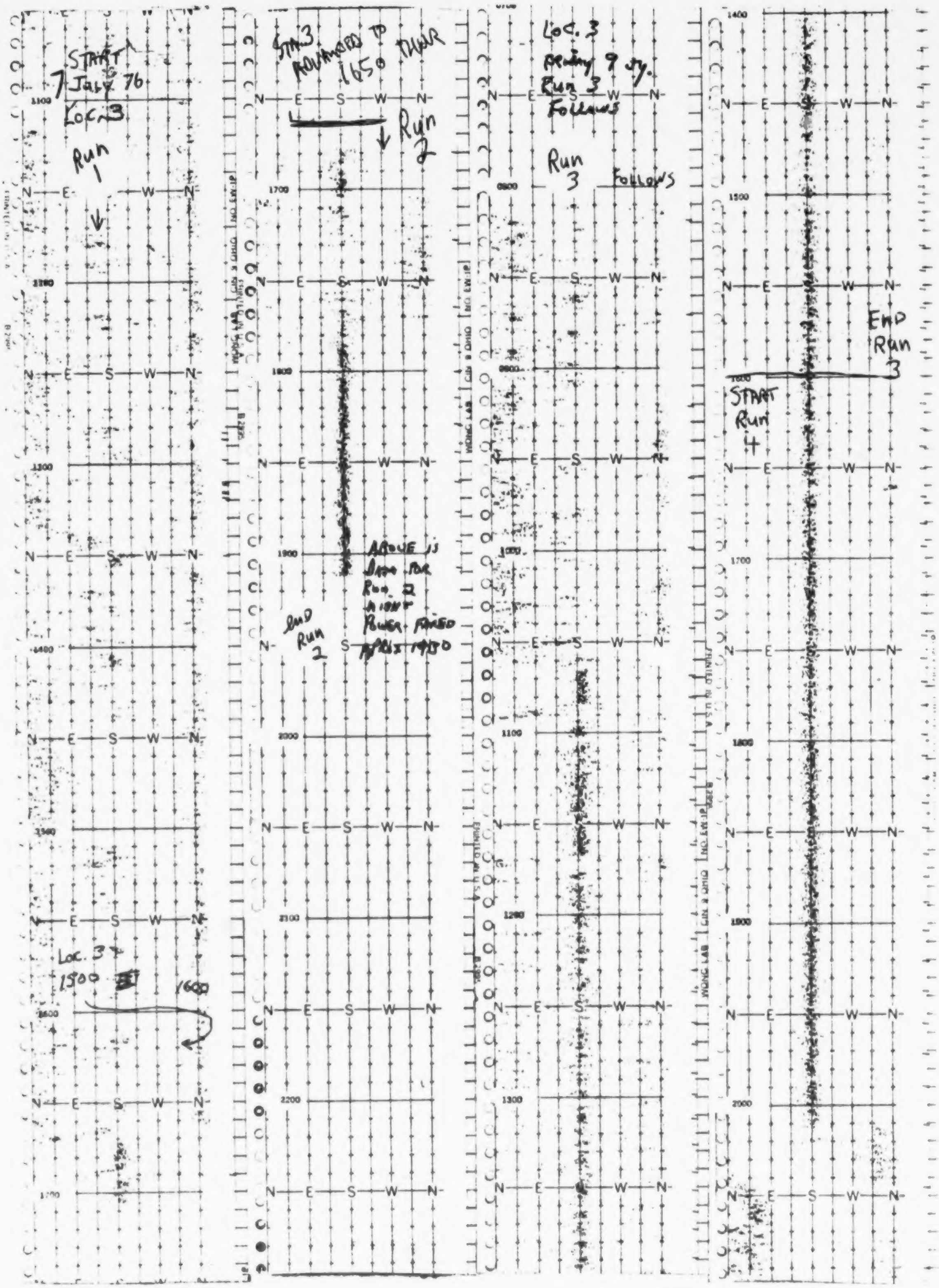
Location 24-5
0800
26 JY 76
Run 23

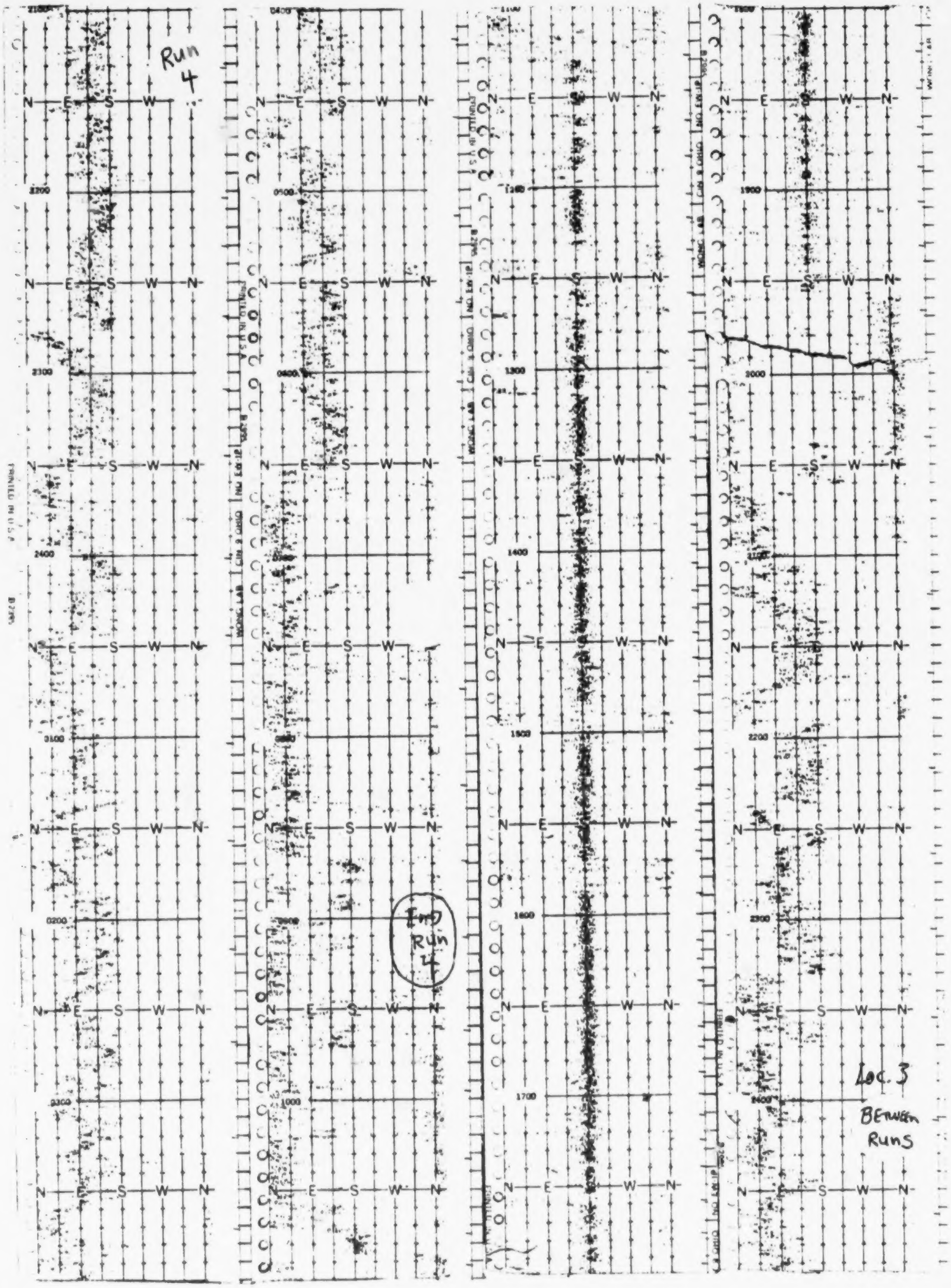
End Run 23

Loc 24-5
27 JY 76
Run 25 START

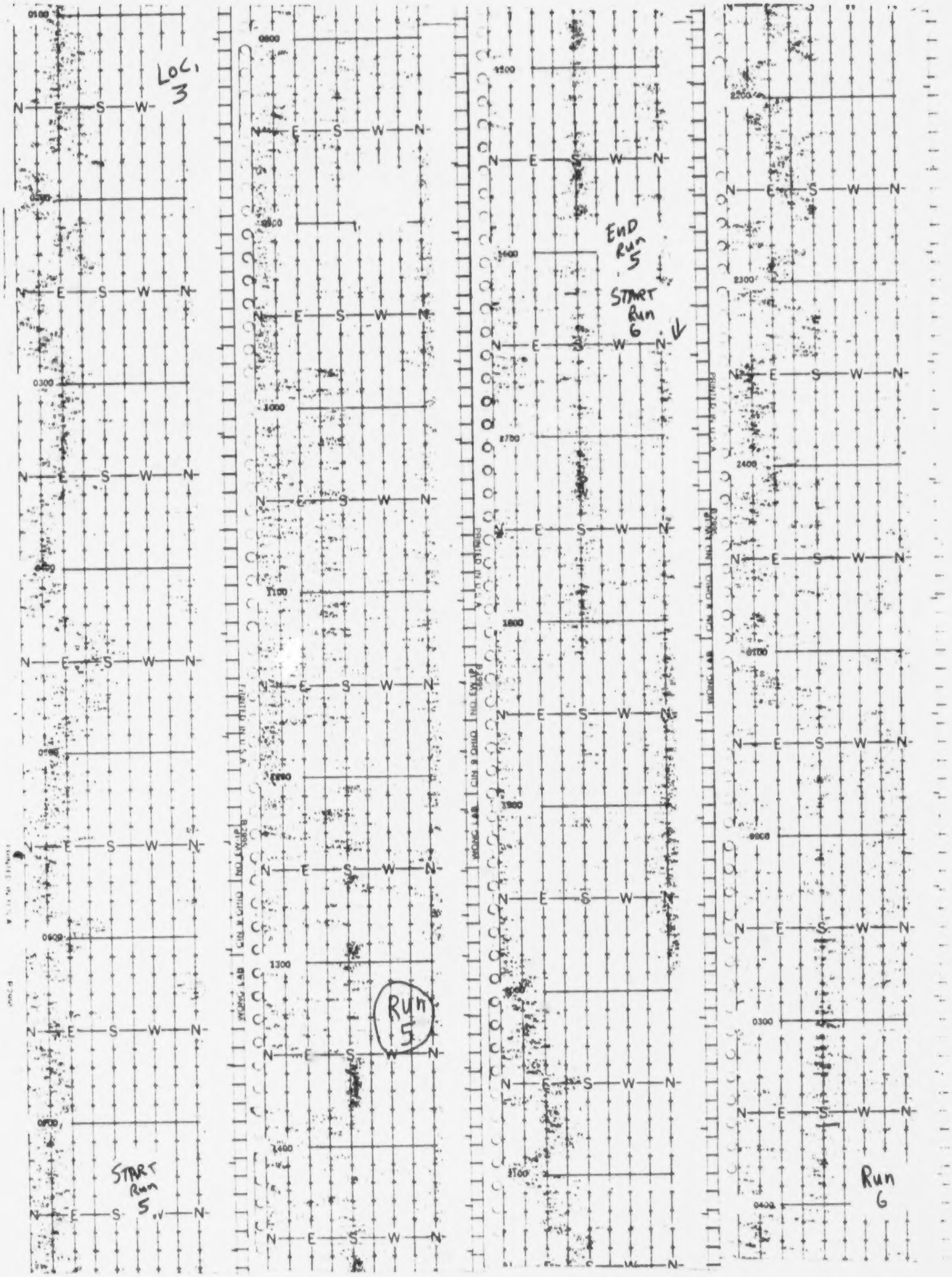
End of Run 25
Loc. 24 South
Ore Loading

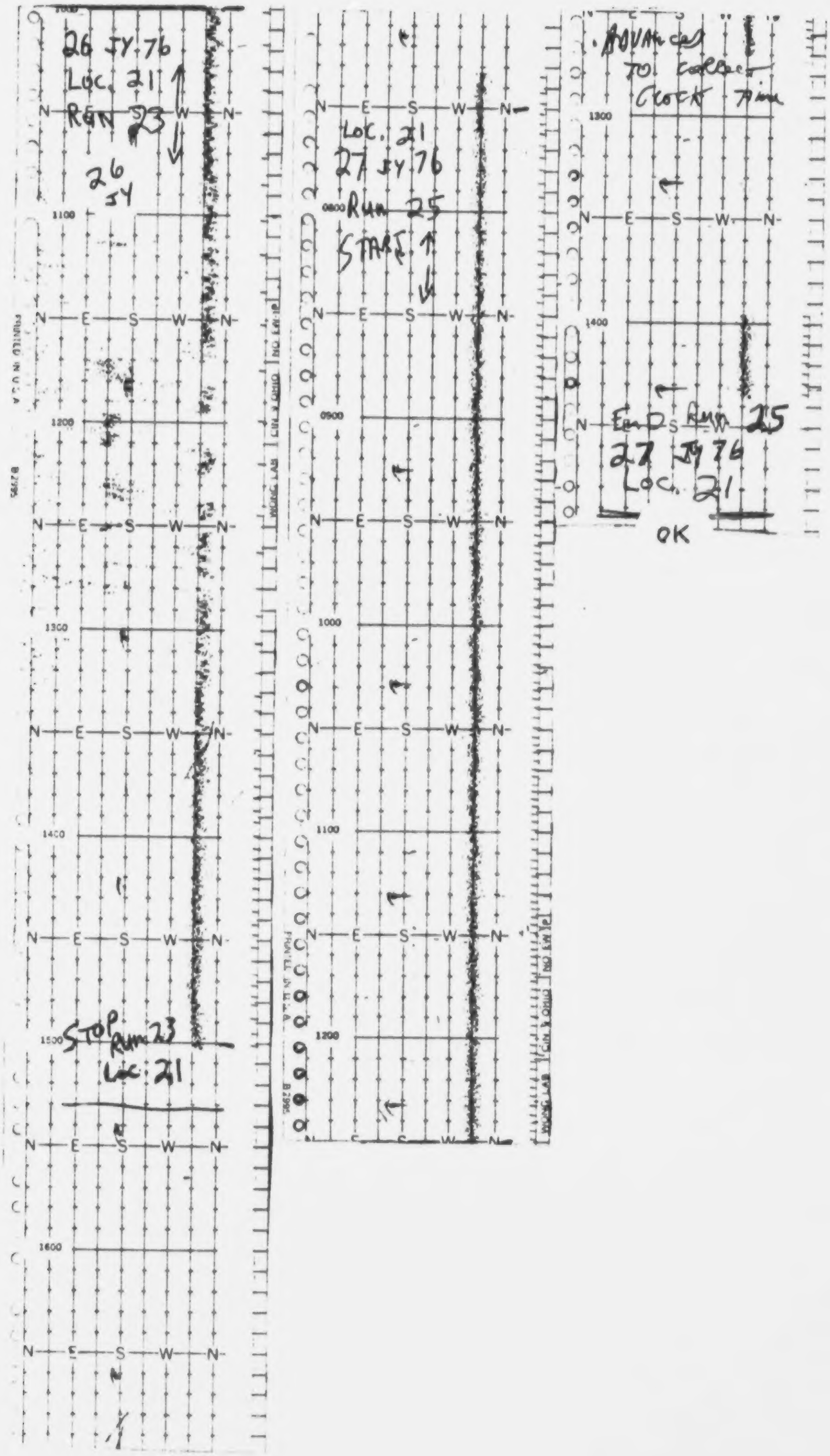

Location 4A 1000 14 JY 76
Run 10
Run 10
4A End Run 10
Run 11
Run 11 End
Location 4A End 1300 15 JY 76
N E S W N
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300
WONG LAB CIN. & OHIO NO. EW-1P

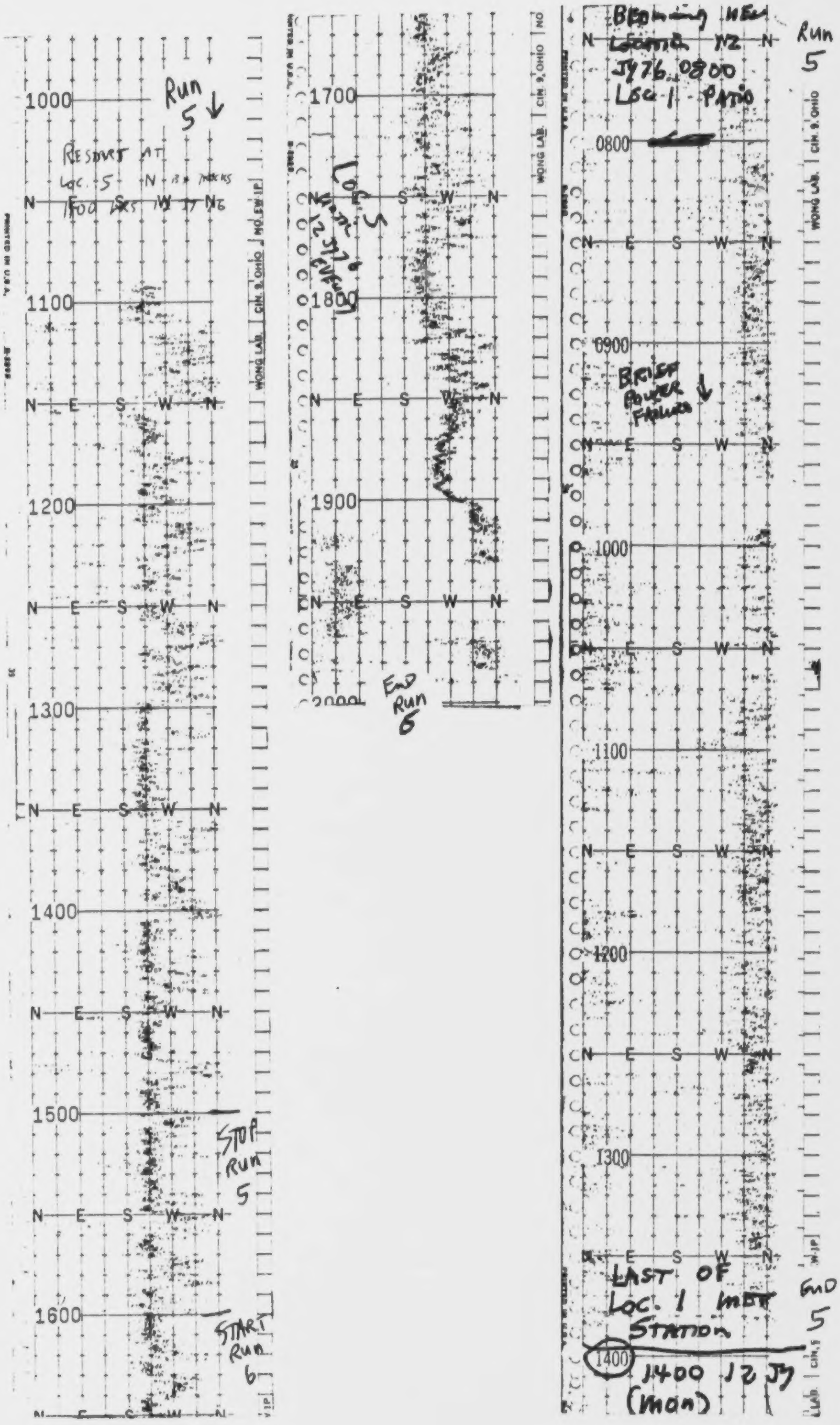

START
7 July 76
Loc. 3
Run 1
Sta 3 advanced to 1650 thur
Run 2
Above is data for Run 2
end Run 2
Loc. 3
Run 3 follows
Run 3 follows
End Run 3
START Run 4
Loc. 3
1500
1600
1100
1200
1300
1400
1500
1600
1700
1700
1800
1900
2000
2100
2200
0800
0900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
N
E
S
W
N
WONG LAB
CIN 9 OHIO
NO EW-1P
PRINTED IN U.S.A.

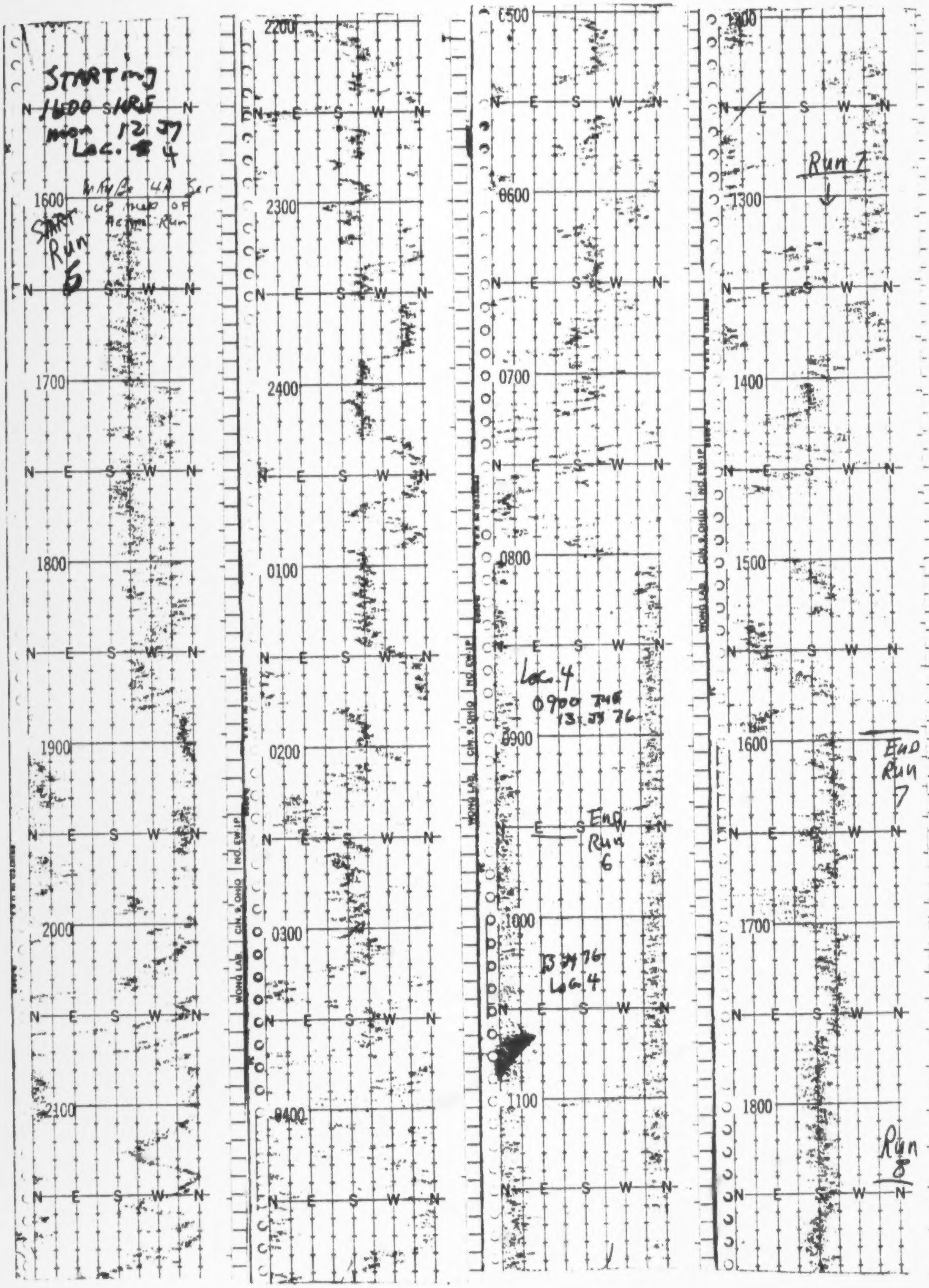


Run 4
N
E
S
W
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
End Run 4
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
Loc. 3
BETWEEN Runs
PRINTED IN U.S.A.
WONG LAB CIN 3 OHIO NO EA-12


LOC. 3
N E S W N
START Run 5
Run 5
END Run 5
START Run 6
Run 6


26 JY 76
Loc. 21
RUN 23
26 JY
1100
N E S W N
1200
1300
1400
1500
STOP Run 23
Loc. 21
1600
PRINTED IN U.S.A.
Loc. 21
27 JY 76
0800 Run 25
START
0900
1000
1100
1200
· ADVANCED TO CORRECT CLOCK TIME
1300
1400
END Run 25
27 JY 76
Loc. 21
OK


1000
Run 5 ↓
RESTART AT
Loc. 5
1500 hrs 12 JY 76
1100
1200
1300
1400
1500
STOP RUN 5
1600
START RUN 6
1700
Loc 5
12 JY 76
1800
1900
2000
END RUN 6
Beginning New Location 12
JY76 0800
Loc 1 - Patio
Run 5
0800
0900
BRIEF POWER FAILURE ↓
1000
1100
1200
1300
LAST OF Loc. 1 MET STATION
END 5
1400
1400 12 JY
(Mon)
N E S W N
WONG LAB. CIN. 9, OHIO
PRINTED IN U.S.A.



STARTING
1600 SHRF
MON 12 JY
LOC. # 4

Wiley 4R Ser
up head of
Actual Run

START
Run
6

Loc. 4
0900 TUE
13 JY 76

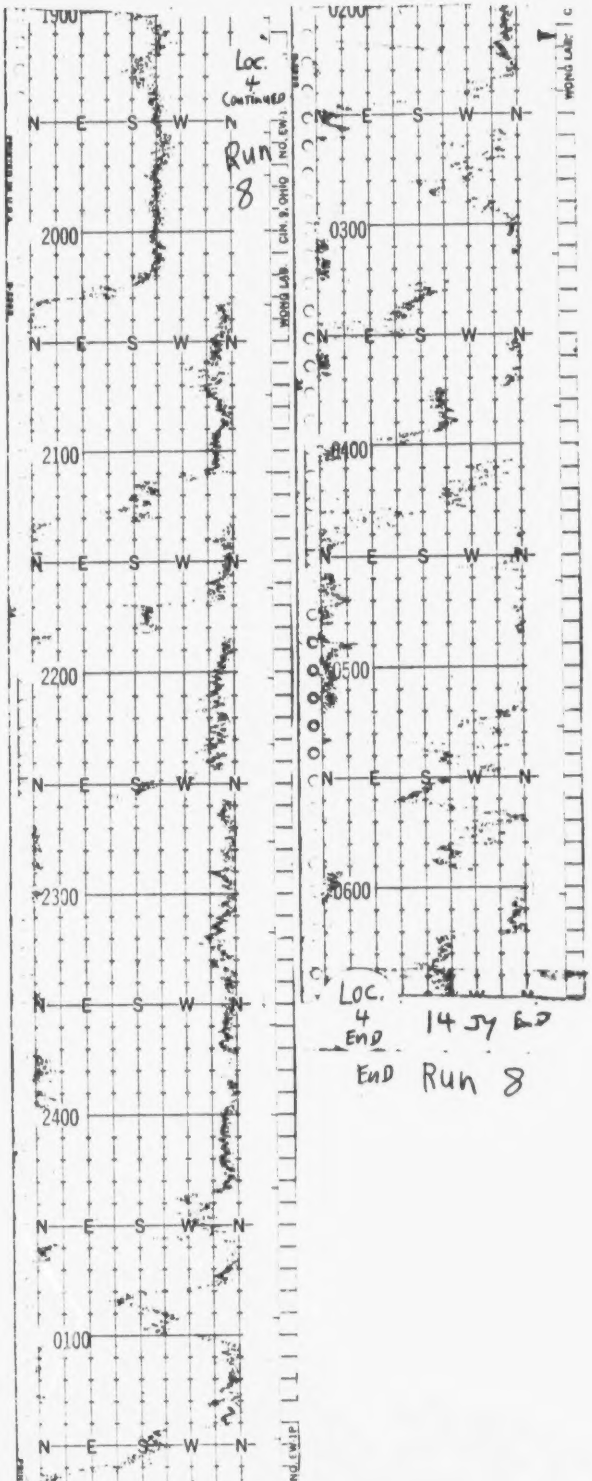
End
Run
6

13 JY 76
Loc 4

Run 7

End
Run
7

Run
8



Loc. 4 Continued

Run 8

Loc. 4 End

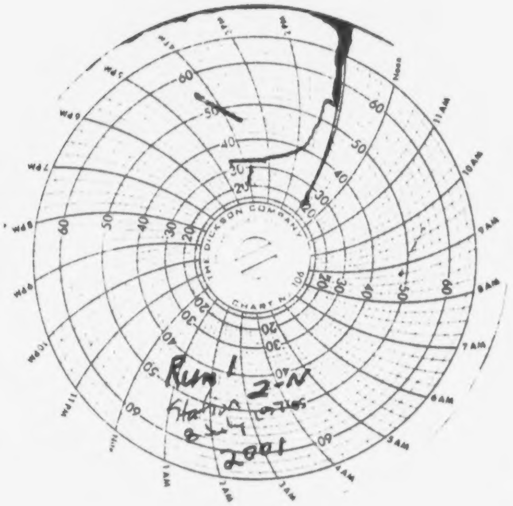
14 JY 62

End Run 8

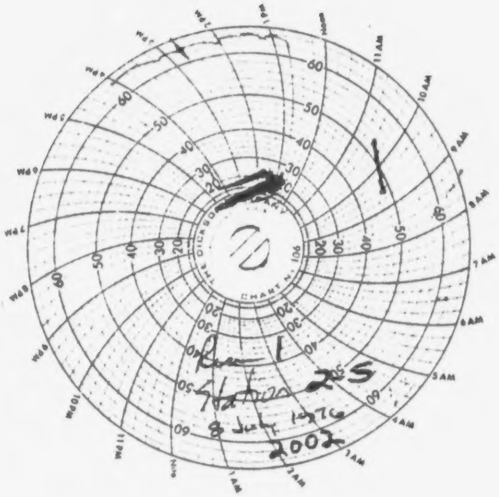
APPENDIX K

HiVol SAMPLER RECORDER CHARTS - GLOVER, MISSOURI

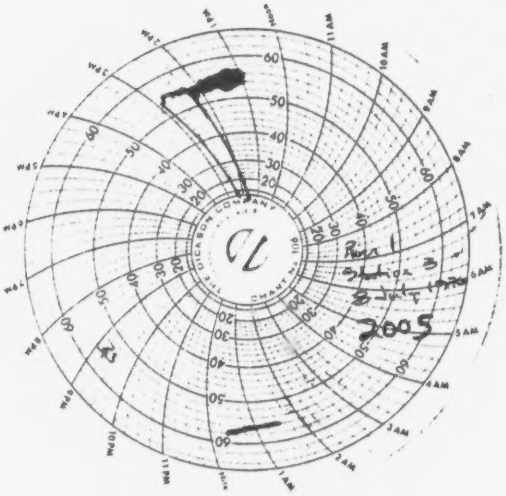
The charts in this appendix constitute raw field data. These data must be adjusted by calibration data for the individual samplers used. The adjustment is shown below each chart.



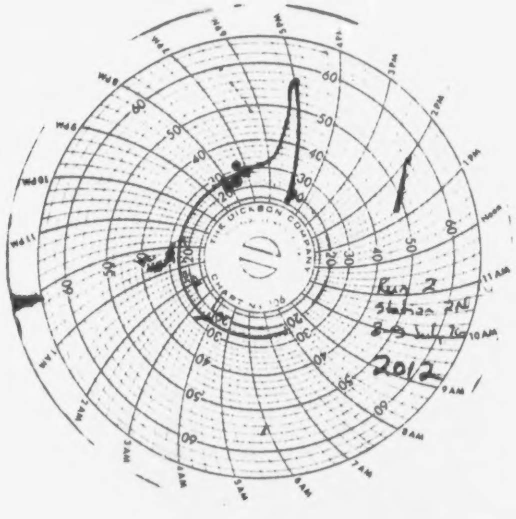
1300-1632
39 x 1.09 = 42
HiVol Run No. 1, Location 2N



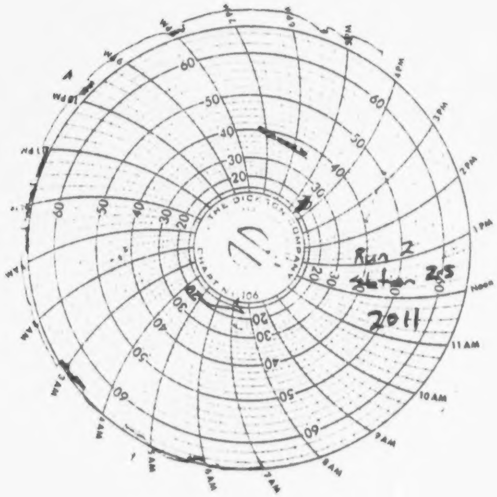
1310-1640
38 x 0.96 = 37 cfm
HiVol Run No. 1, Location 2S



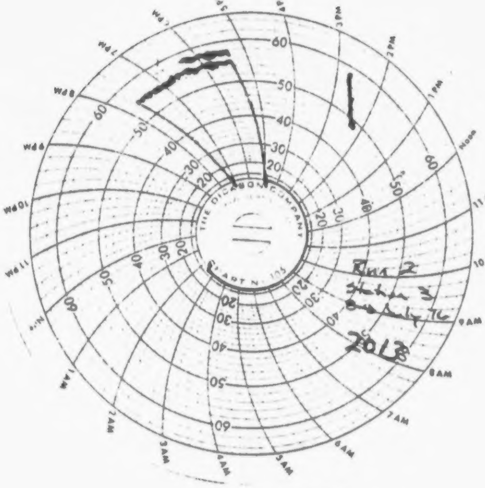
1303-1530
55 x 0.94 = 53 cfm
HiVol Run No. 1, Location 3



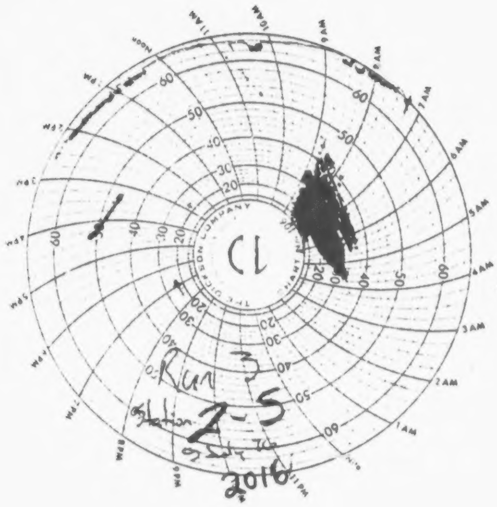
1635-725
(27-20) x 1.09 = 18 cfm
HiVol Run No. 2, Location 2N



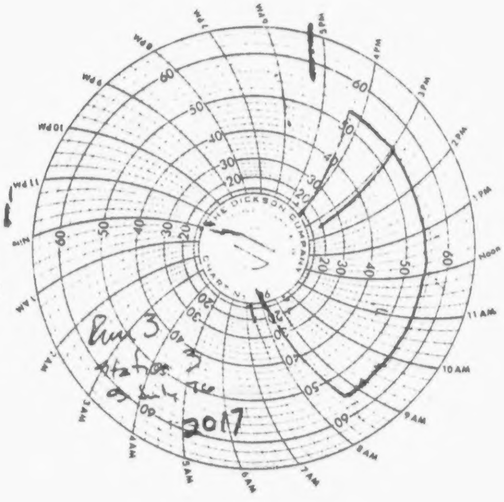
1640-730
(66-24) x 0.96 = 40 cfm
HiVol Run No. 2, Location 2S



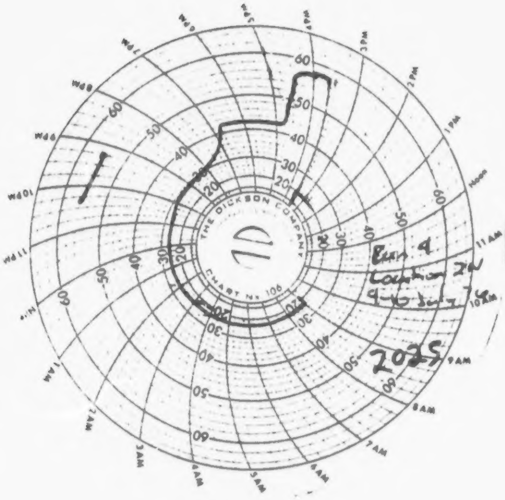
1650-1930
55 x 0.94 = 53 cfm
HiVol Run No. 2, Location 3



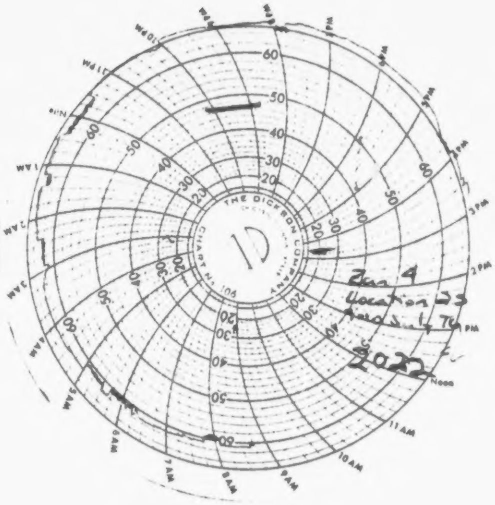
730-1505
(64-24) x 0.96 = 38 cfm
HiVol Run No. 3, Location 2S



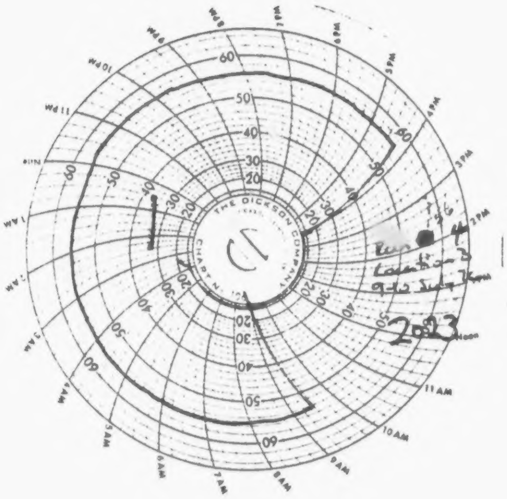
730-1545
55 x 0.94 = 53 cfm
HiVol Run No. 3, Location 3



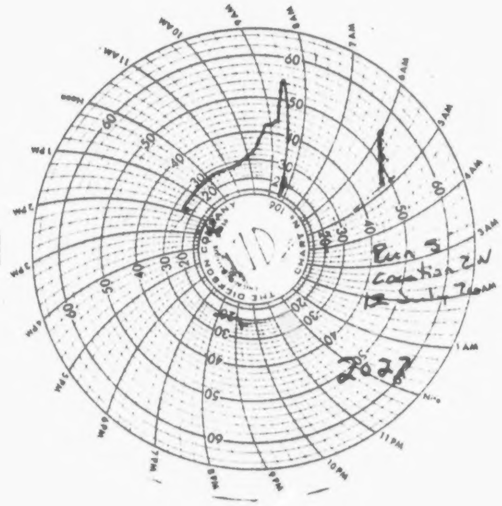
1535-905
(30-20) x 1.09 = 11 cfm
HiVol Run No. 4, Location 2N



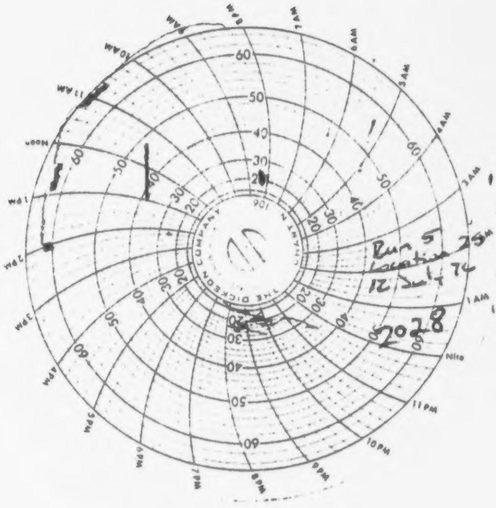
1540-905
(64-24) x 0.94 = 38 cfm
HiVol Run No. 4, Location 2S



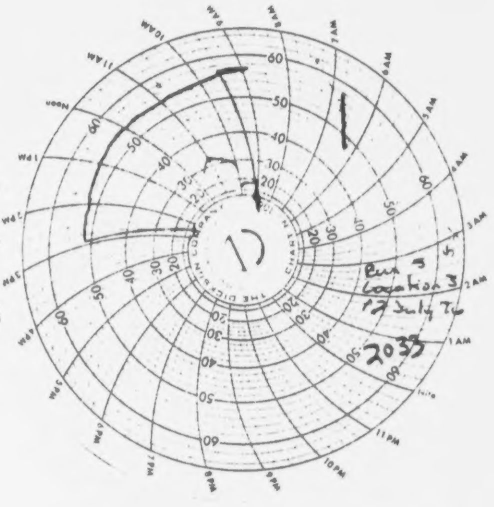
1540-905
56 x 0.94 = 53 cfm
HiVol Run No. 4, Location 3



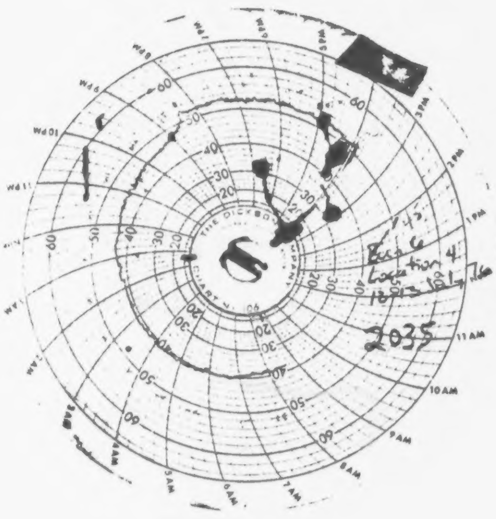
830-1415
(32-20) x 1.09 = 13 cfm
HiVol Run No. 5, Location 2N



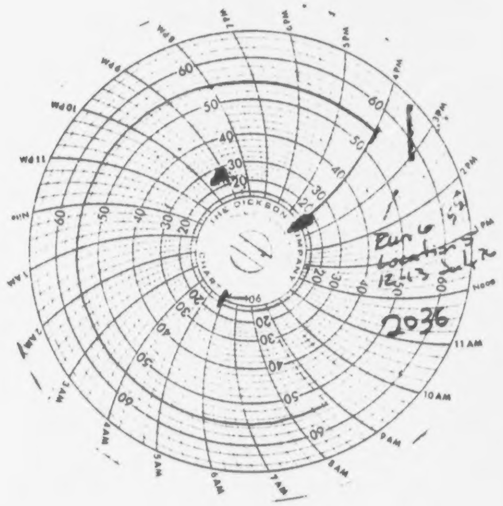
830-1415
(64-24) x 0.96 = 39 cfm
HiVol Run No. 5, Location 2S



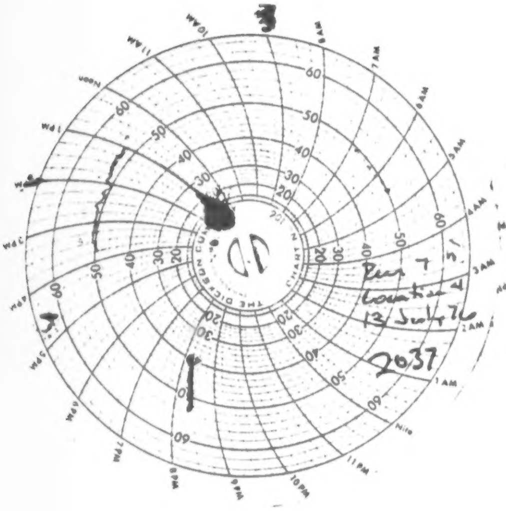
900-1500
54 x 0.96 = 52 cfm
HiVol Run No. 5, Location 3



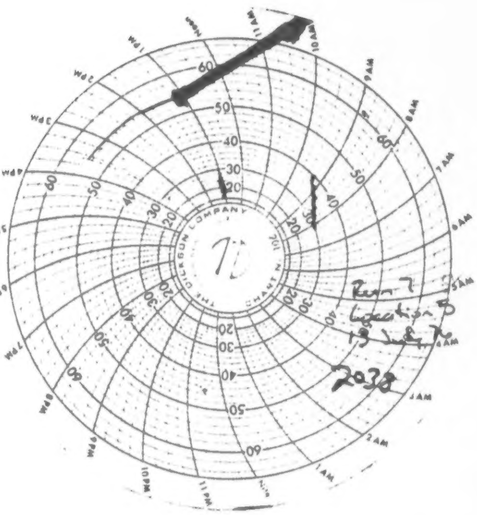
1600-915
45 x 1.13 = 50 cfm
HiVol Run No. 6, Location 4



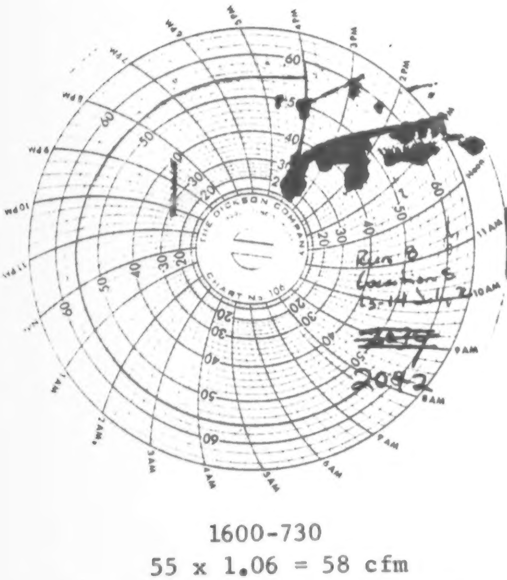
1600-915
55 x 1.06 = 58 cfm
HiVol Run No. 6, Location 5



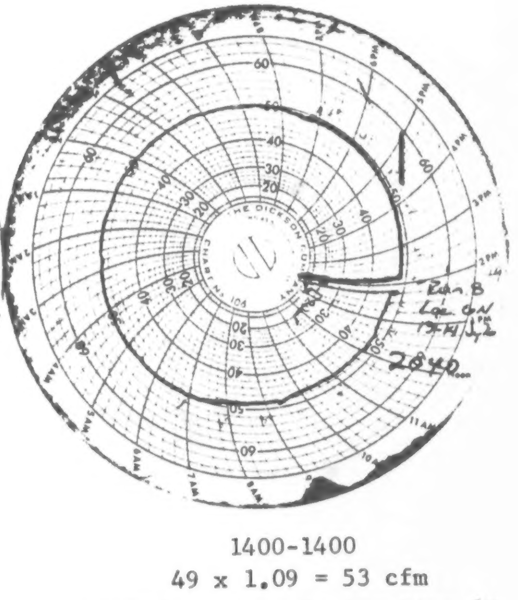
1300-1545
51 x 1.13 = 57 cfm
HiVol Run No. 7, Location 4



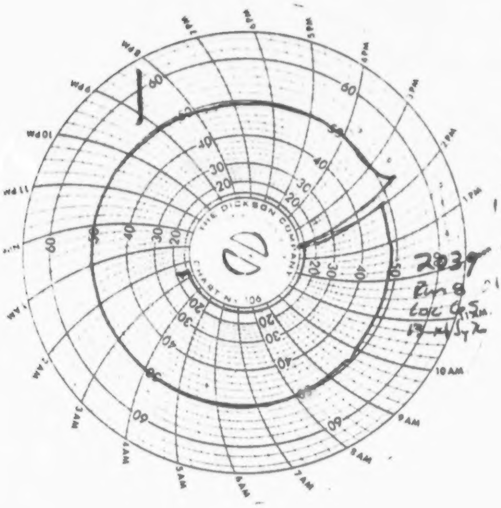
1300-1545
54 x 1.06 = 57 cfm
HiVol Run No. 7, Location 5



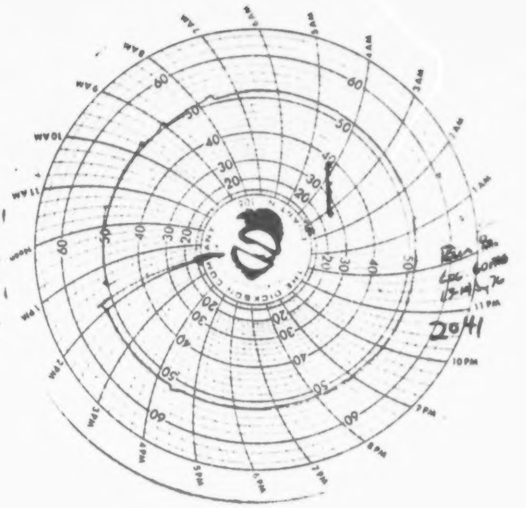
1600-730
55 x 1.06 = 58 cfm
HiVol Run No. 8, Location 5



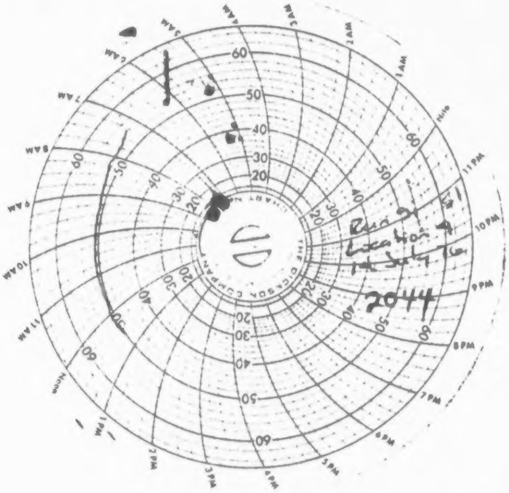
1400-1400
49 x 1.09 = 53 cfm
HiVol Run No. 8, Location 6N



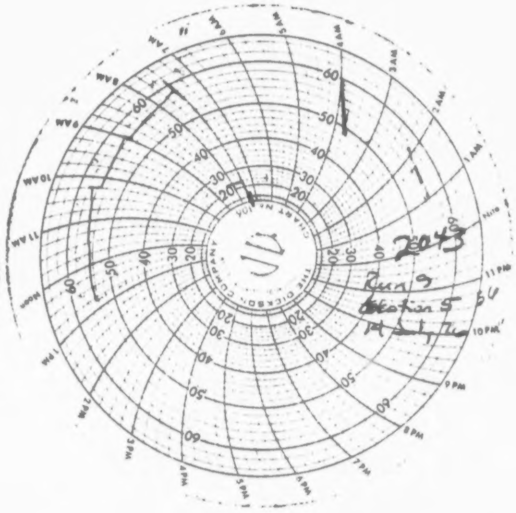
1400-1400
50 x 0.94 = 47 cfm
HiVol Run No. 8, Location 6S



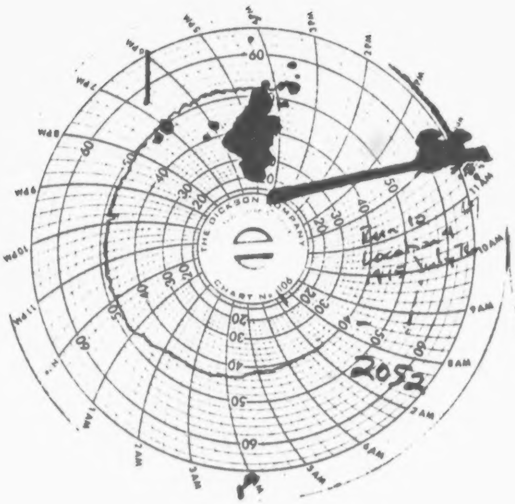
1400-1400
50 x 0.96 = 48 cfm
HiVol Run No. 8, Location 6 - Overpass



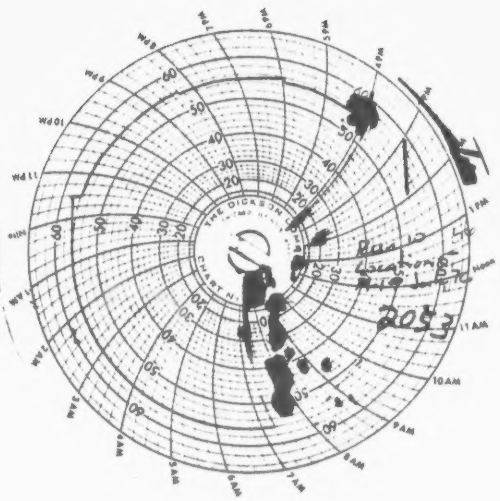
725-1245
51 x 1.13 = 58 cfm
HiVol Run No. 9, Location 4



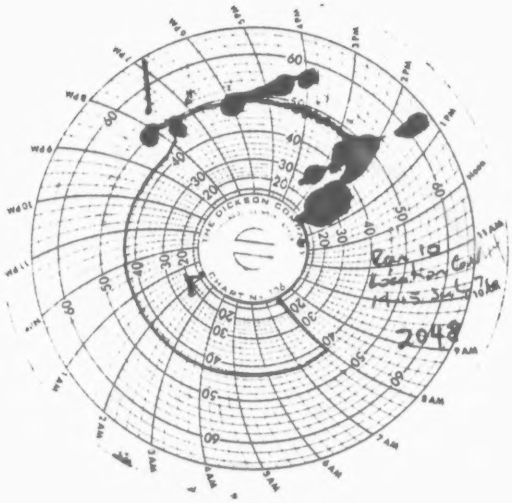
730-1245
56 x 1.06 = 59 cfm
HiVol Run No. 9, Location 5



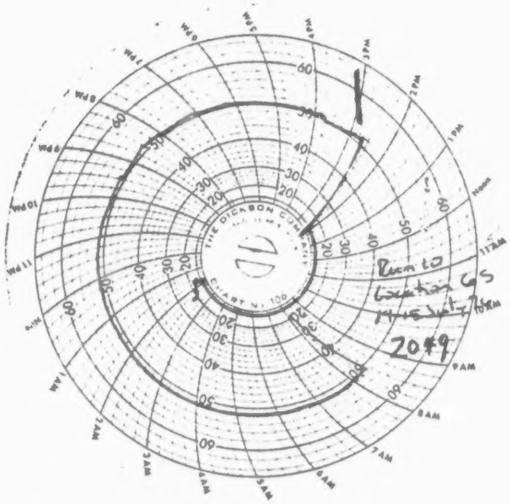
1600-720
47 x 1.13 = 53 cfm
HiVol Run No. 10, Location 4



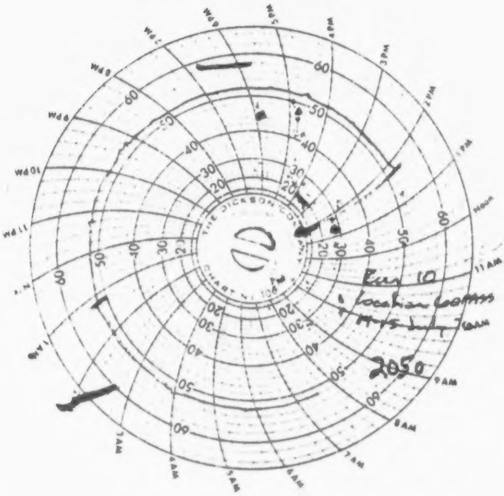
1600-730
56 x 1.06 = 59 cfm
HiVol Run No. 10, Location 5



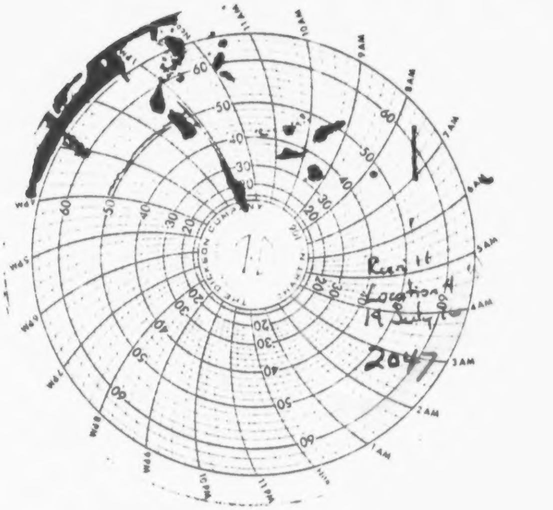
1400-800
44 x 1.09 = 48 cfm
HiVol Run No. 10, Location 6N



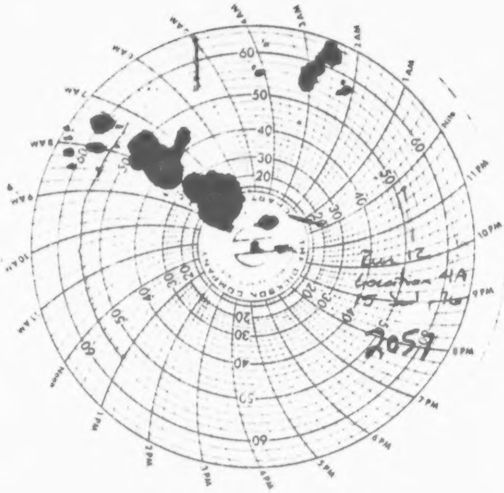
1400-800
51 x 0.94 = 48 cfm
HiVol Run No. 10, Location 6S



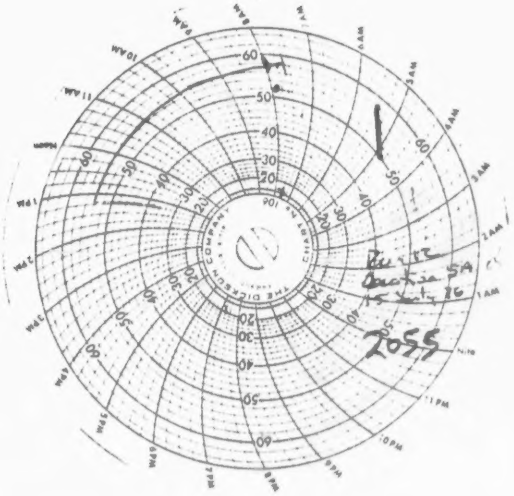
1400-800
52 x 0.96 = 50 cfm
HiVol Run No. 10, Location 6 - Overpass



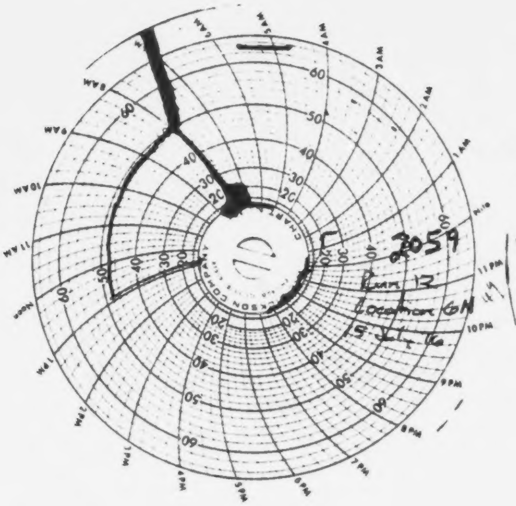
1230-1600
51 x 1.13 = 58 cfm
HiVol Run No. 11, Location 4



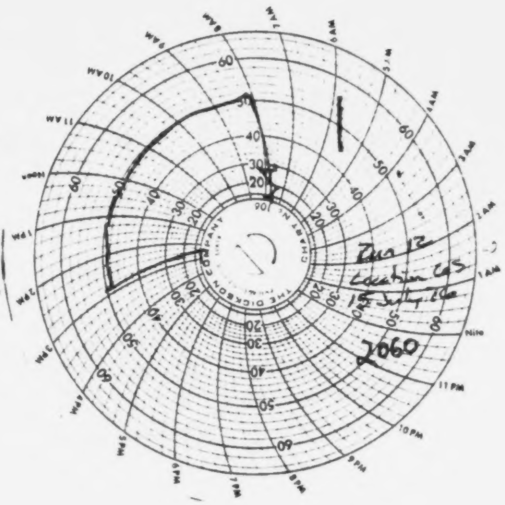
720-1300
55 x 1.13 = 62 cfm
HiVol Run No. 12, Location 4A



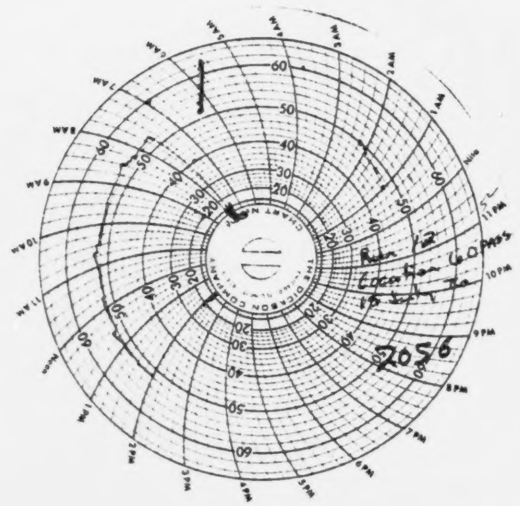
730-1300
55 x 1.06 = 58 cfm
HiVol Run No. 12, Location 5A



800-1245
49 x 1.09 = 53 cfm
HiVol Run No. 12, Location 6N



800-1430
50 x 0.94 = 47 cfm
HiVol Run No. 12, Location 6S

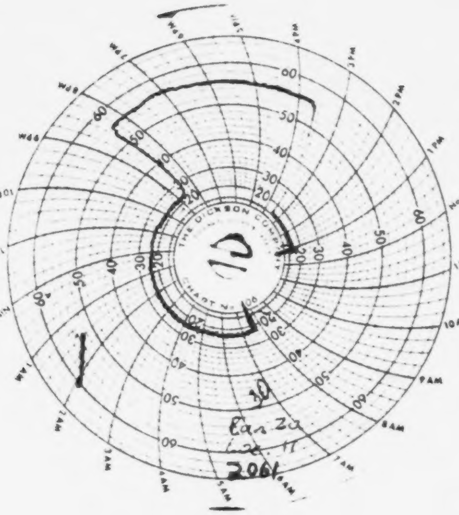


800-1415
52 x 0.96 = 50 cfm
HiVol Run No. 12, Location 6 -
Overpass

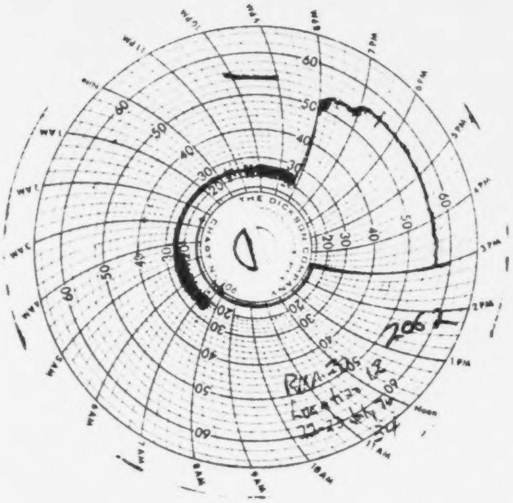
APPENDIX L

HiVol RECORDER CHARTS, EAST HELENA, MONTANA

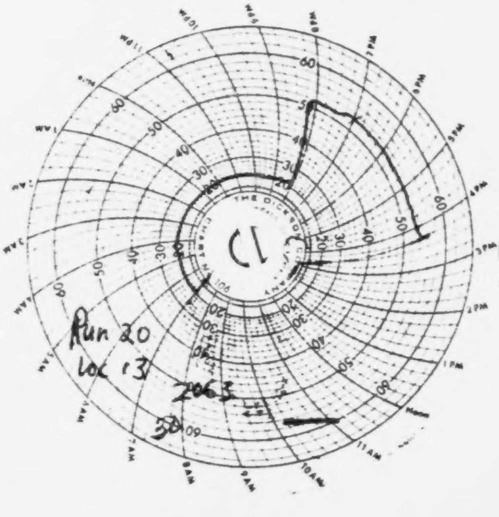
The charts in this appendix constitutes raw field data. These data must be adjusted by calibration data for the individual samplers used. The adjustment is shown below each chart.



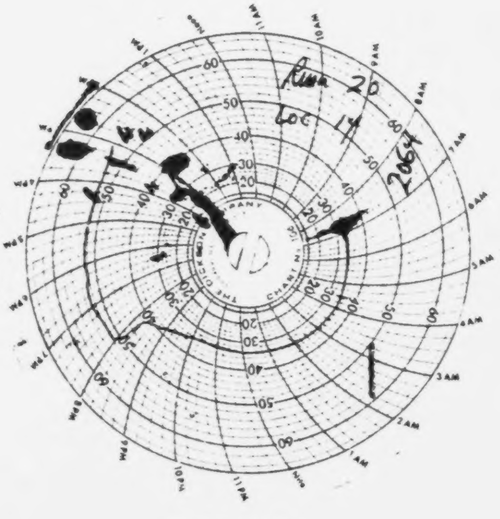
1530-0744
30 x 1.09 = 33 cfm
Hivol Run No. 20, Location 11



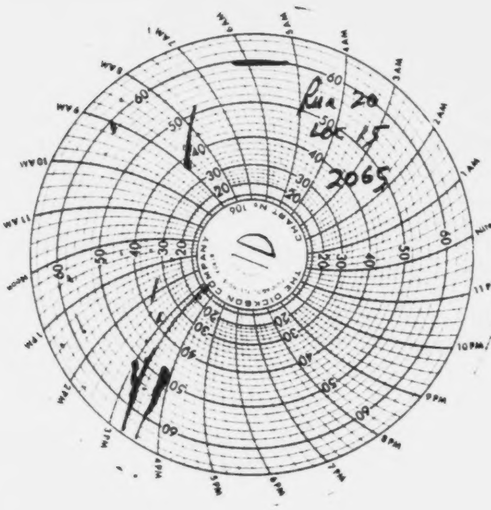
1520-754
34 x 0.96 = 33 cfm
HiVol Run No. 20, Location 12



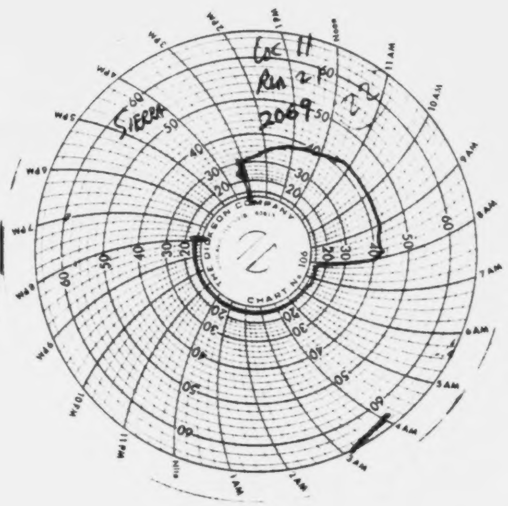
1550-738
30 x 0.94 = 28 cfm
HiVol Run No. 20, Location 13



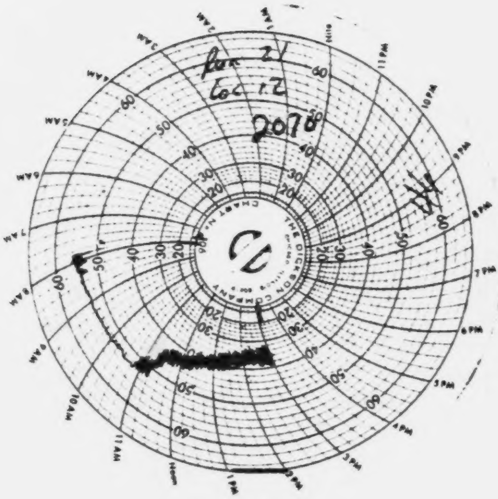
1520-740
40 x 1.13 = 45 cfm
HiVol Run No. 20, Location 14



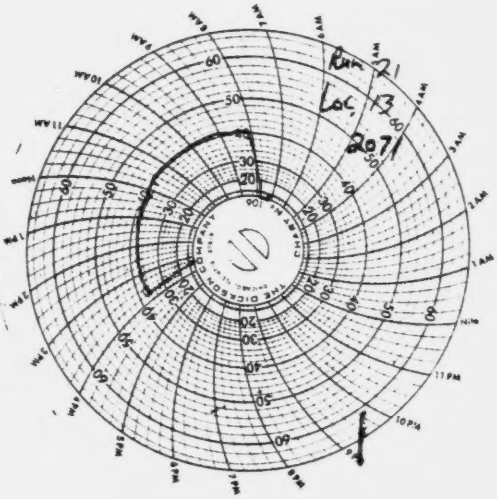
1530-800
42 x 1.07 = 45 cfm
HiVol Run No. 20, Location 15



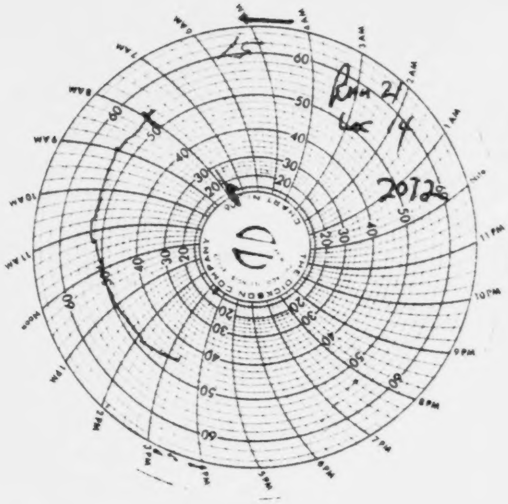
752-1510
22 x 1.09 = 24 cfm
HiVol Run No. 21, Location 11



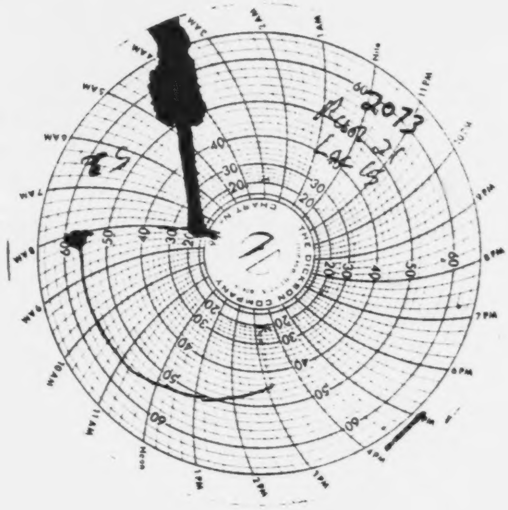
807-1520
46 x 0.96 = 44 cfm
HiVol Run No. 21, Location 12



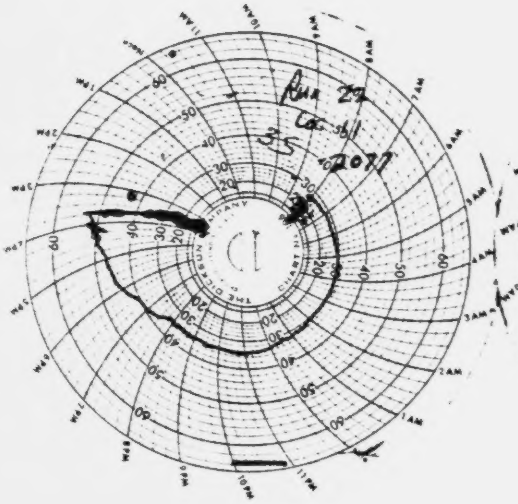
742-1540
40 x 0.94 = 38 cfm
HiVol Run No. 21, Location 13



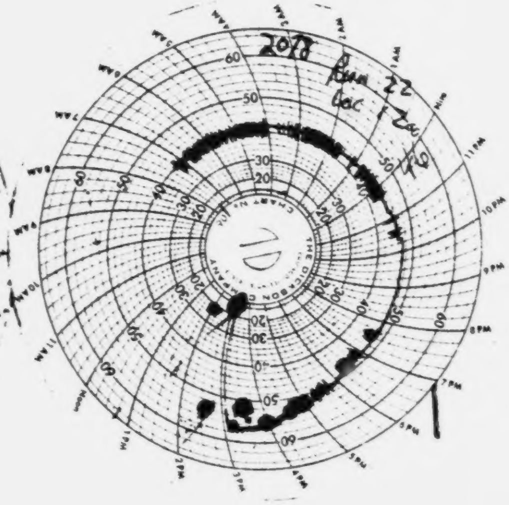
750-1526
51 x 1.13 = 58 cfm
HiVol Run No. 21, Location 14



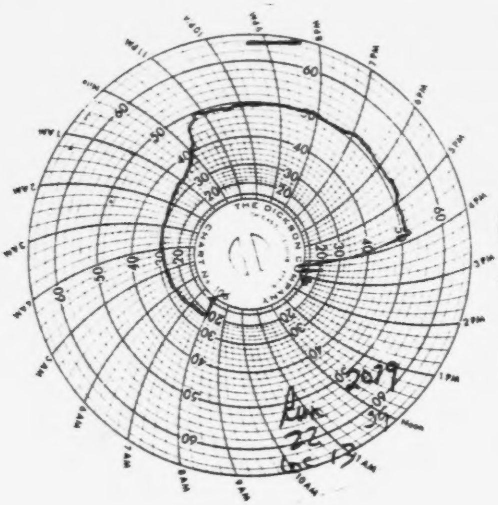
800-1508
52 x 1.06 = 55 cfm
HiVol Run No. 21, Location 15



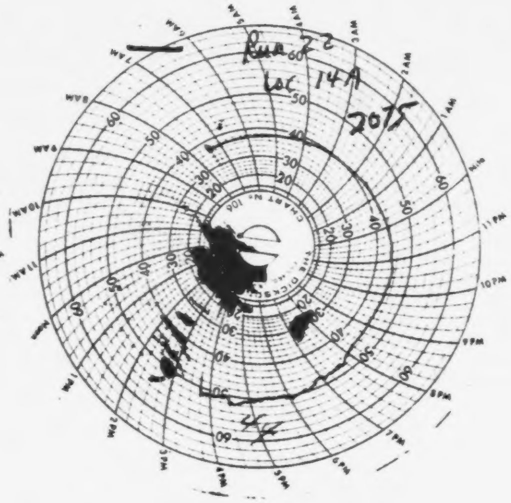
1515-740
35 x 1.09 = 38 cfm
HiVol Run No. 22, Location 11



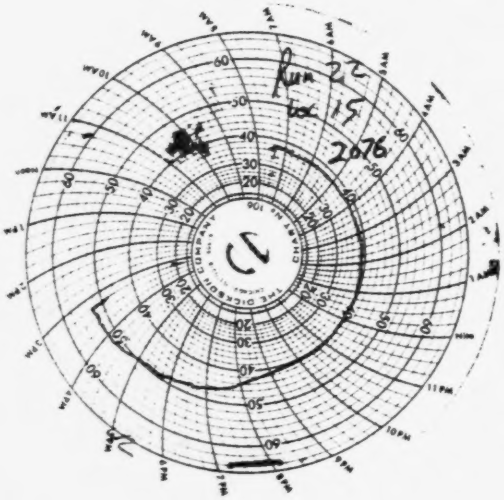
1530-745
46 x 0.96 = 44 cfm
HiVol Run No. 22, Location 12



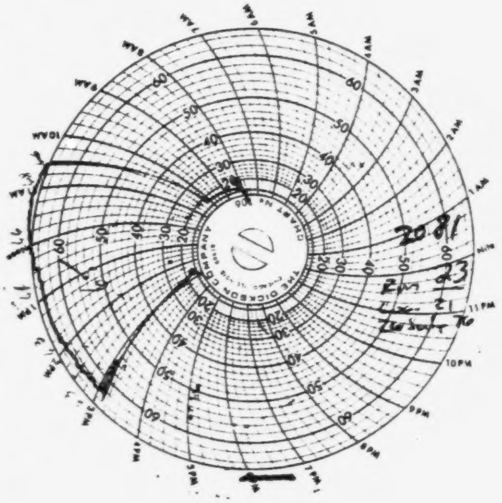
1540-750
39 x 0.94 = 37 cfm
HiVol Run No. 22, Location 13



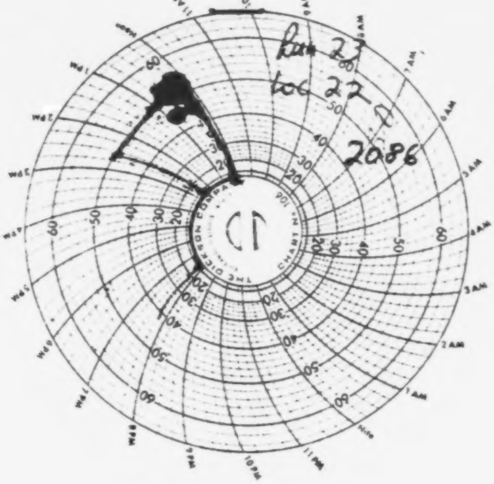
1547-735
44 x 1.13 = 49 cfm
HiVol Run No. 22, Location 14A



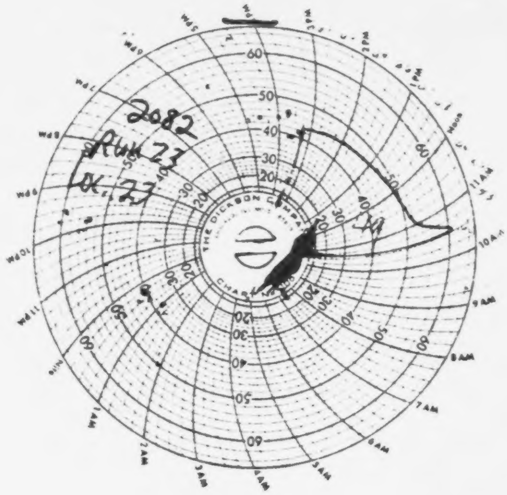
1514-750
42 x 1.06 = cfm
HiVol Run No. 22, Location 15



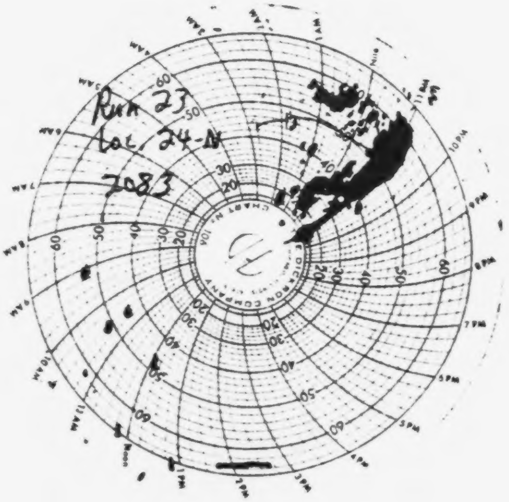
1005-1445
65 x 0.94 = 61 cfm
HiVol Run No. 23, Location 21



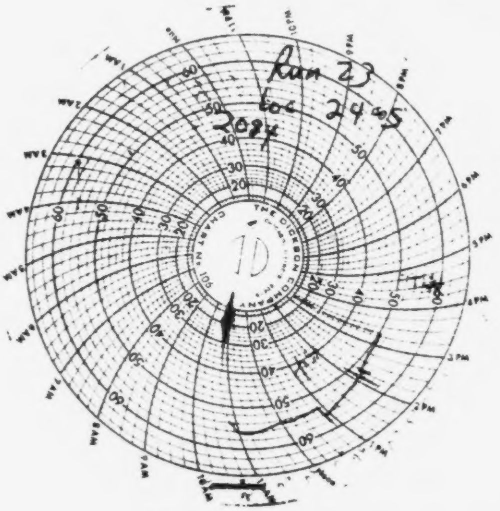
1220-1450
50 x 1.09 = 54 cfm
HiVol Run No. 23, Location 22



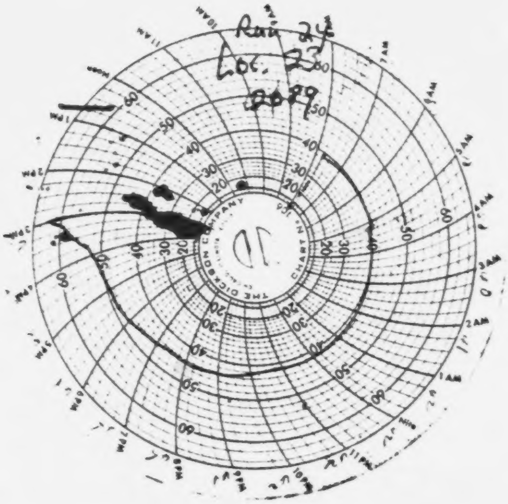
1030-1457
49 x 0.96 = 47 cfm
HiVol Run No. 23, Location 23



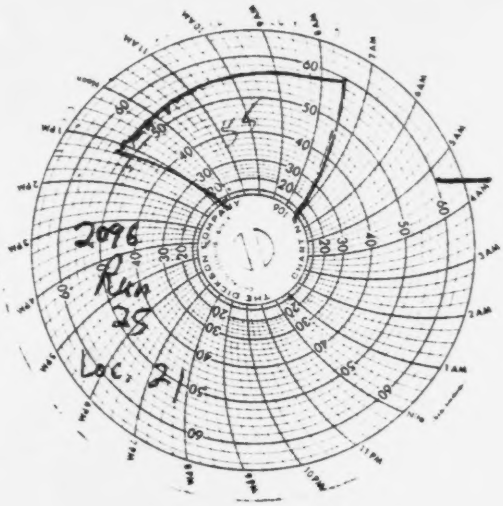
1035-1515
48 x 1.13 = 54 cfm
HiVol Run No. 23, Location 24N



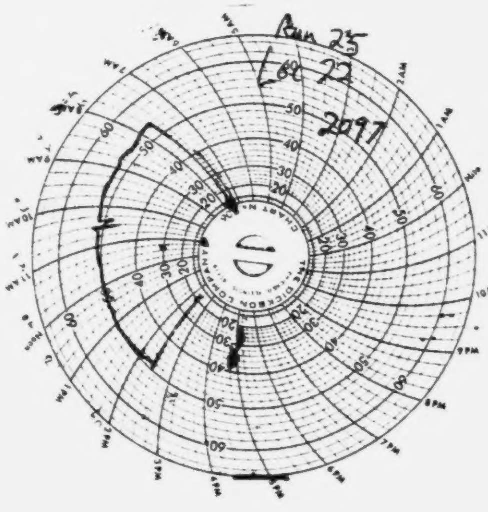
1040-1520
54 x 1.06 = 57 cfm
HiVol Run No. 23, Location 24S



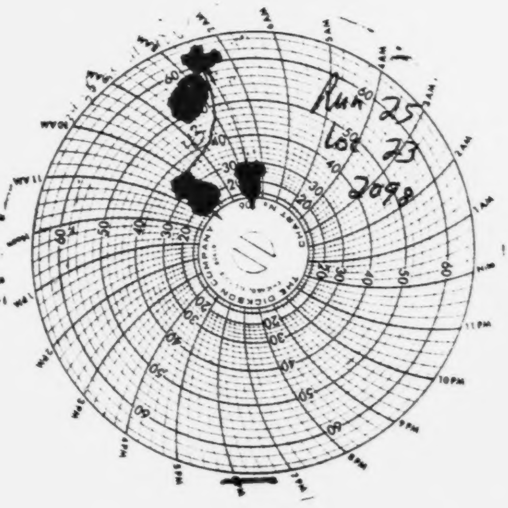
1501-0750
44 x 0.96 = 43 cfm
HiVol Run No. 24, Location 23



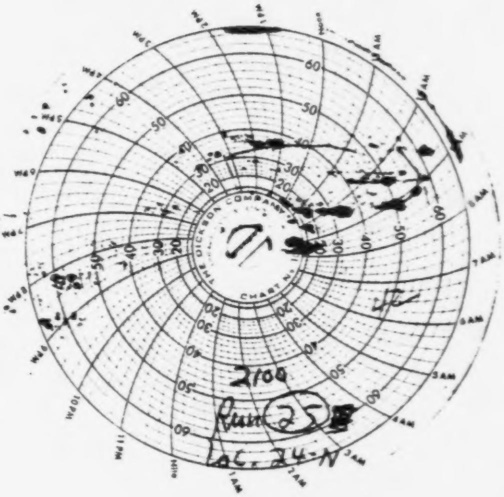
730-1425
55 x 0.94 = 52 cfm
HiVol Run No. 25, Location 21



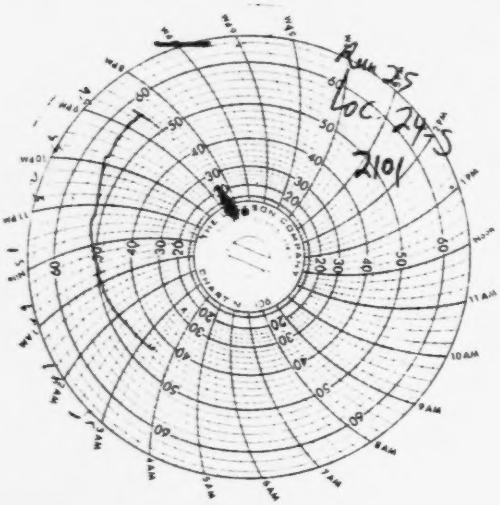
735-1430
51 x 1.09 = 56 cfm
HiVol Run No. 25, Location 22



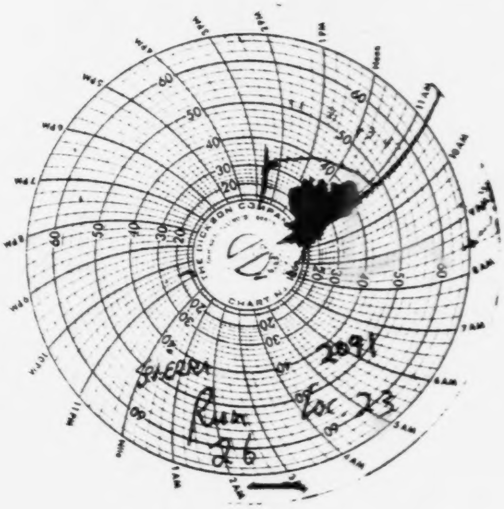
753-1045
43 x 0.96 = 41 cfm
HiVol Run No. 25, Location 23



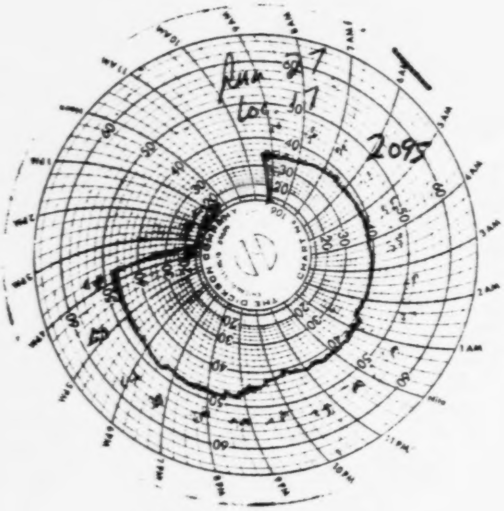
820-1500
42 x 1.13 = 47 cfm
HiVol Run No. 25, Location 24N



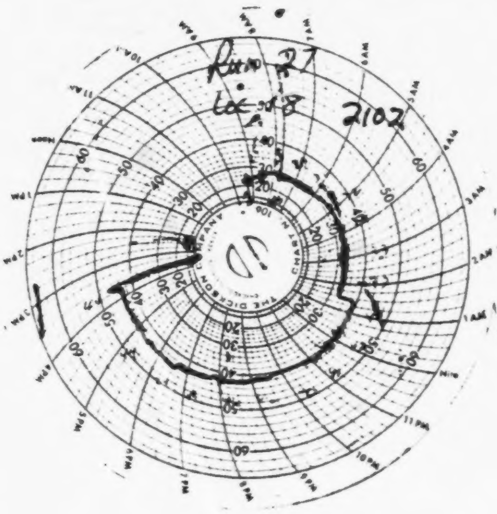
810-1510
51 x 1.06 = 54 cfm
HiVol Run No. 25, Location 24S



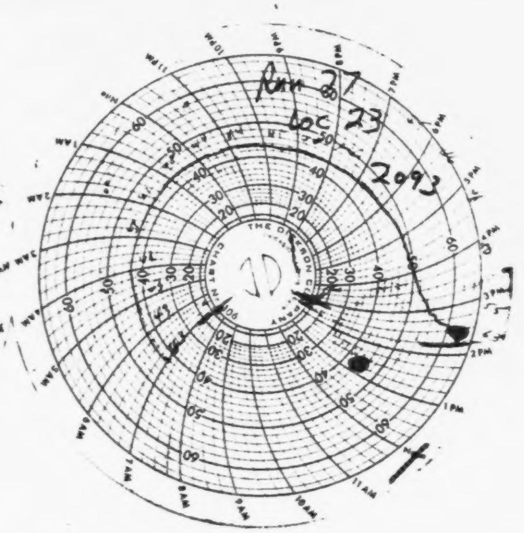
1055-1445
40 x 0.96 = 39 cfm
HiVol Run No. 26, Location 23



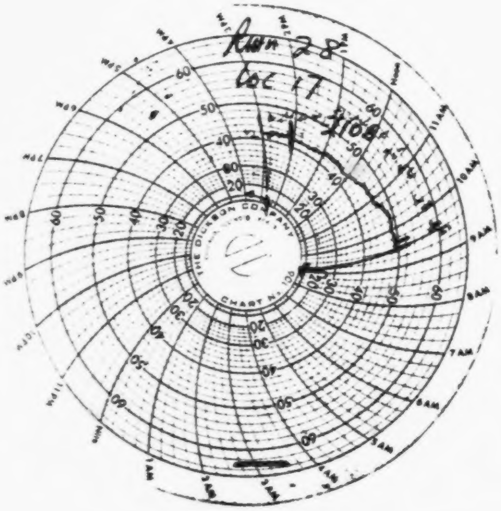
1530-930
42 x 0.94 = 39 cfm
HiVol Run No. 27, Location 17



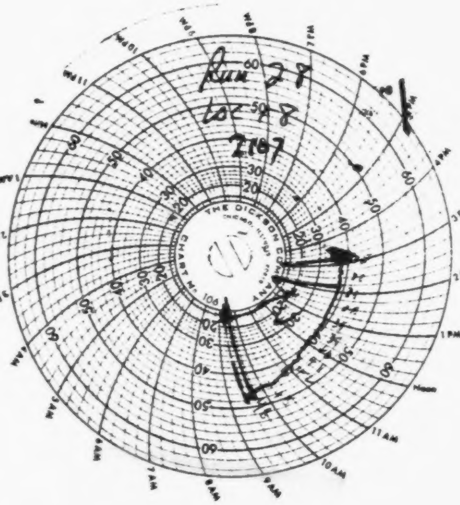
1530-920
37 x 1.09 = 40 cfm
HiVol Run No. 27, Location 18



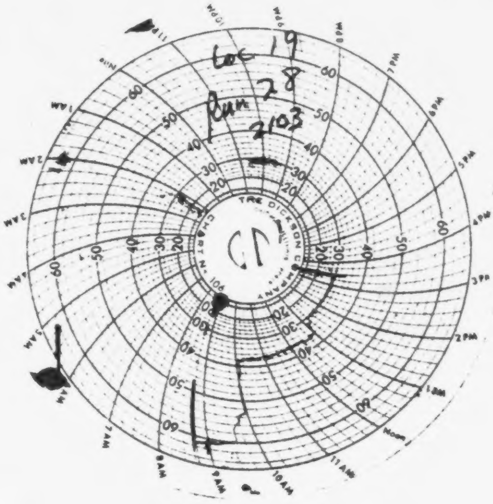
1447-0725
46 x 0.96 = 44 cfm
HiVol Run No. 27, Location 23



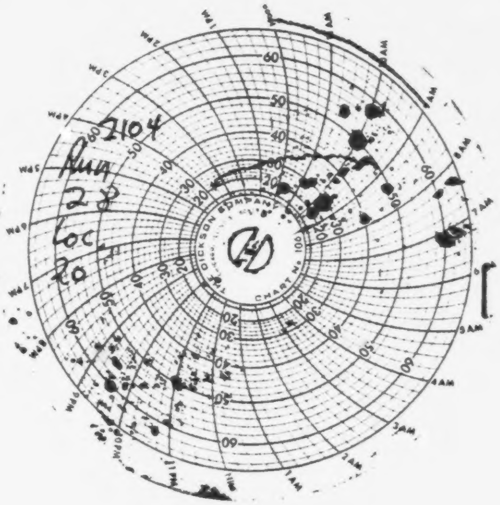
935-1505
44 x 0.94 = 41 cfm
HiVol Run No. 28, Location 17



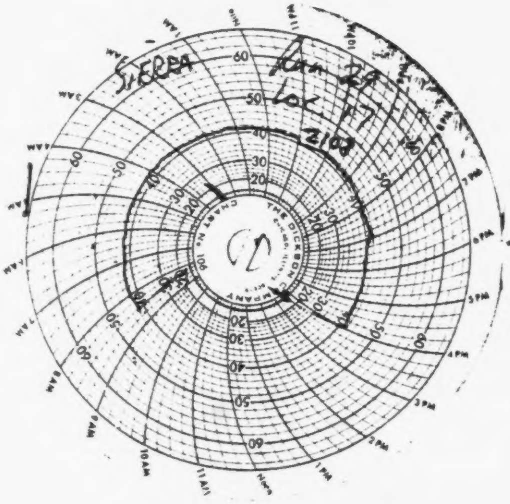
925-1510
40 x 1.09 = 44 cfm
HiVol Run No. 28, Location 18



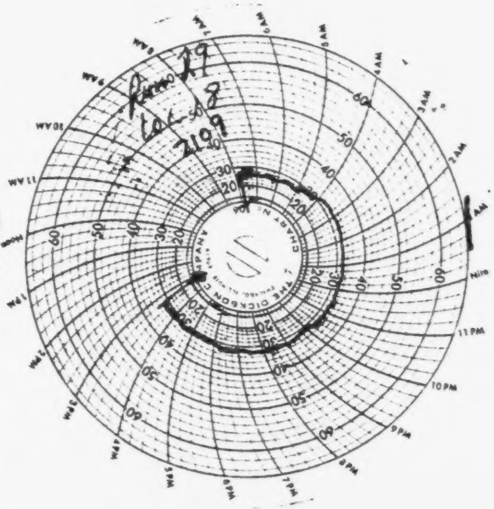
850-1530
39 x 1.06 = 41 cfm
HiVol Run No. 28, Location 19



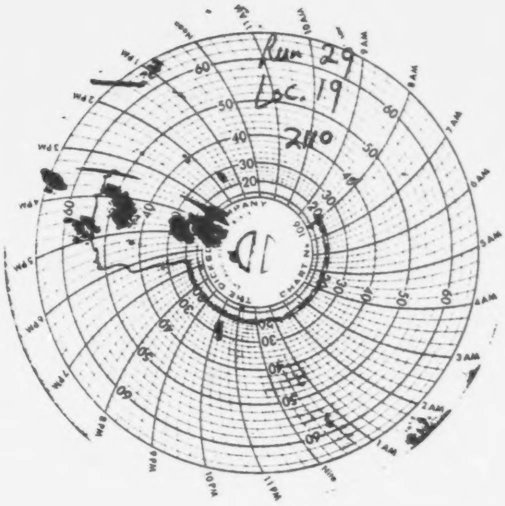
900-1530
33.5 x 1.13 = 38 cfm
HiVol Run No. 28, Location 20



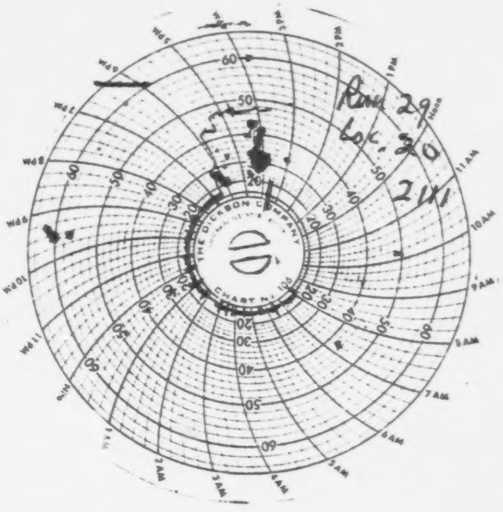
1515-745
41 x 0.94 = 38 cfm
HiVol Run No. 29, Location 17



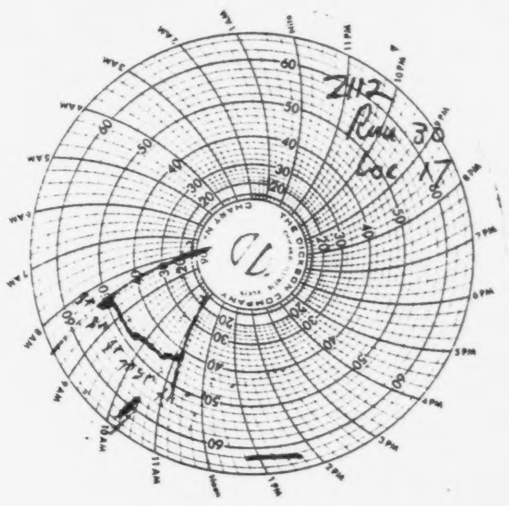
1520-740
32 x 1.09 = 35 cfm
HiVol Run No. 29, Location 18


Run 29
Loc. 19
2110

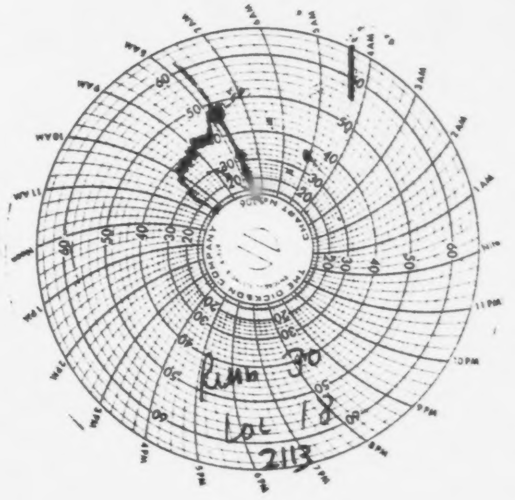
1530-810
25 x 1.06 = 27 cfm
HiVol Run No. 29, Location 19


Run 29
Loc. 20
2111

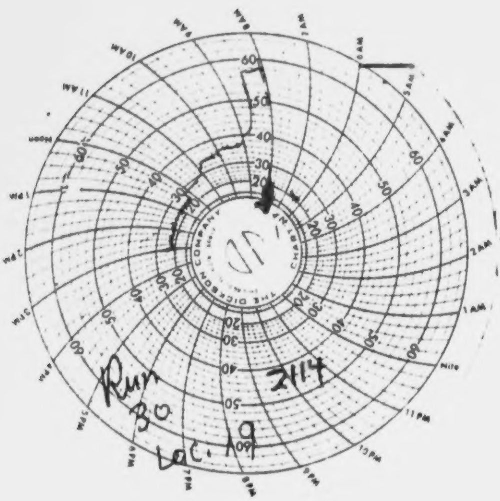
1535-815
14 x 1.13 = 16 cfm
HiVol Run No. 29, Location 20


2112
Run 30
Loc 17

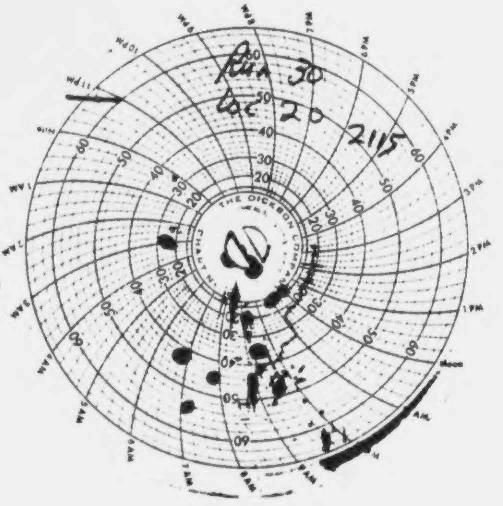
747-1035
46 x 0.94 = 44 cfm
HiVol Run No. 30, Location 17


Run 30
Loc 18
2113

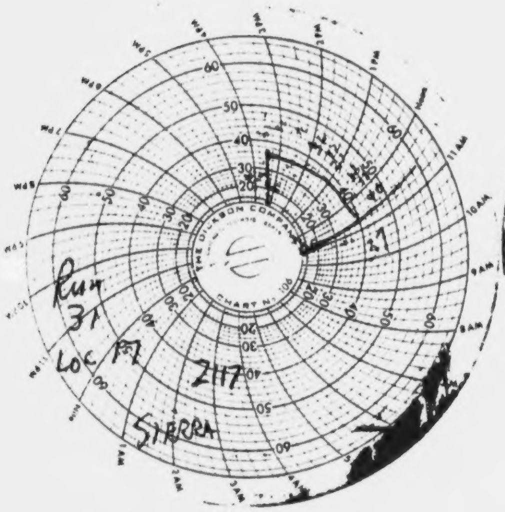
745-1050
40 x 1.09 = 44 cfm
HiVol Run No. 30, Location 18



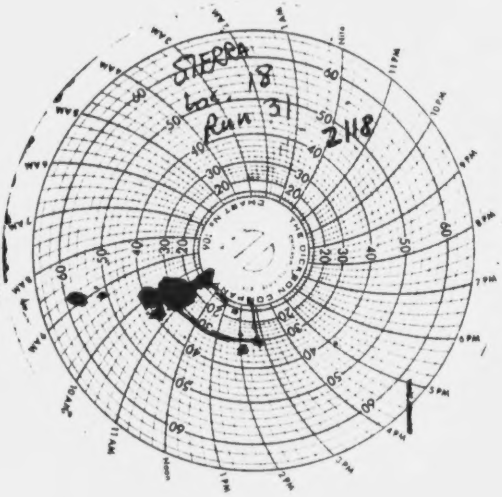
815-1510
33 x 1.06 = 35 cfm
HiVol Run No. 30, Location 19



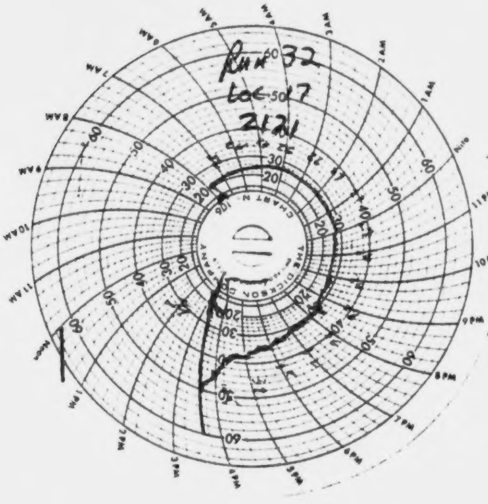
817-1520
28 x 1.13 = 32 cfm
HiVol Run No. 30, Location 20



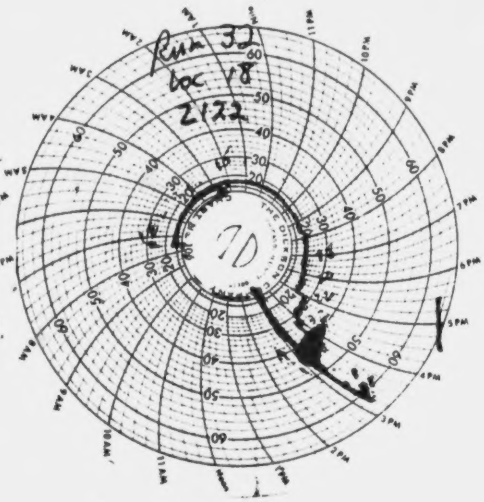
1040-1455
37 x 0.94 = 35 cfm
HiVol Run No. 31, Location 17



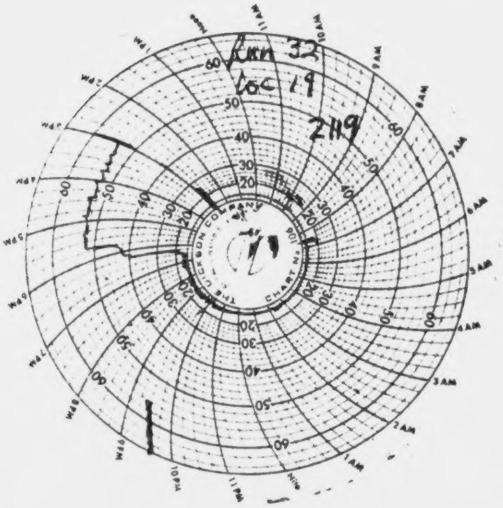
1055-1500
31 x 1.09 = 34 cfm
HiVol Run No. 31, Location 18



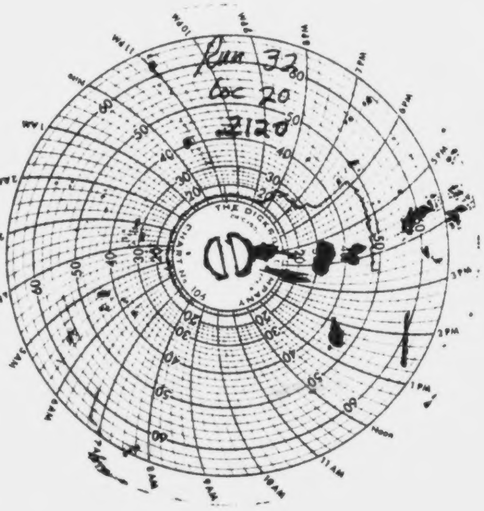
1500-725
29 x 0.94 = 27 cfm
HiVol Run No. 32, Location 17



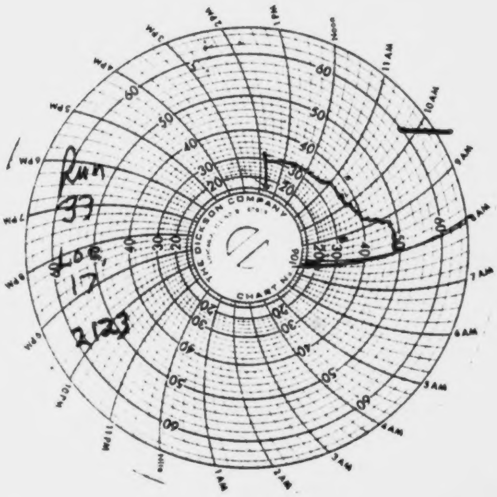
1505-730
17 x 1.09 = 19 cfm
HiVol Run No. 32, Location 18



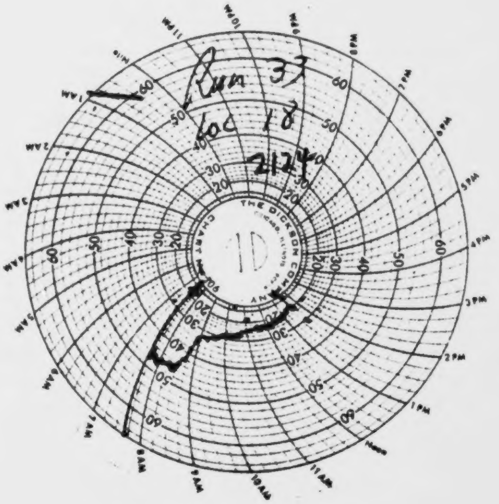
1515-740
21 x 1.06 = 22 cfm
HiVol Run No. 32, Location 19



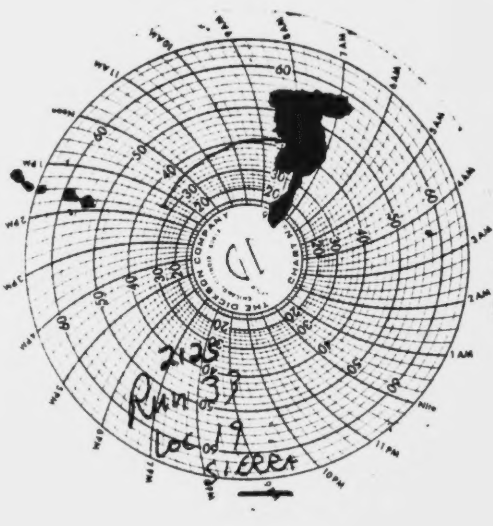
1520-745
18.5 x 1.13 = 21 cfm
HiVol Run No. 32, Location 20



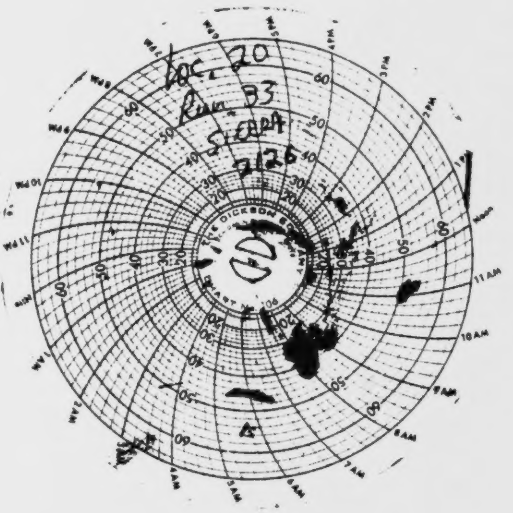
730-1340
39 x 0.94 = 36 cfm
HiVol Run No. 33, Location 17



735-1340
30 x 1.09 = 32 cfm
HiVol Run No. 33, Location 18



740-1400
38 x 1.06 = 41 cfm
HiVol Run No. 33, Location 19



750-1355
29.7 x 1.13 = 34 cfm
HiVol Run No. 33, Location 20

APPENDIX M

CALCULATIONS OF EFFECTIVE AREAS

Introduction

In many cases the fugitive particulates that were emitted from an opening were not evenly distributed over the area (A) of the opening. Consequently to properly estimate the emission rates (based upon samples at one point) it was necessary to devise a technique compensating for this nonuniformity.

For the homogeneous situation, emission rate (E) is the product of the opening area (A), the velocity (V) of the media normal to the opening, and the mass concentration (m) of the element of interest. Thus

$$E = VmA.$$

When mass concentration and velocity are functions of position (P), the above formula is easily extended to the continuous case as

$$E = \int V_P m_P dA.$$

The opening can be divided into smaller regions as desired and the emission rate formula then becomes

$$E = V \sum_i m_i A_i \tag{1}$$

with the assumption of uniform cross-sectional flow.

Let us redefine emission rate by

$$E = VM_m A_e \tag{2}$$

where M_m is the concentration measured at the sampling point and A_e is an "effective area" such that the mass transport balance through the opening is maintained. Equation (1) in conjunction with Equation (2) yields

$$A_e = \frac{\sum m_i A_i}{M_m} \tag{3}$$

but

$$\sum m_i A_i = \left(\frac{\sum m_i A_i}{A}\right)\sum A_i = \overline{m}\sum A_i = \overline{m}A$$

where m_i represent the estimated relative emissions (in terms of M_m) over A_i ,

A is the total area, and

$\overline{m}$ is the average concentration over the total area.

Consequently, $$A_e = \left(\frac{\overline{m}}{M_m}\right)A \qquad (4)$$

where $$\overline{m} = \frac{\sum m_i A_i}{\sum A_i} = \frac{1}{A}\sum m_i A_i \qquad (4a)$$

The emissions are given by

$$E(g/s) = \overline{V}(m/s)M_m(\mu g/m^3)A_e(m^2)10^6$$

where $\overline{V}$ is the average air speed for the area in question, and 10^6 the conversion from micrograms to grams.

The approach to sampling and computation for representative values was as follows:

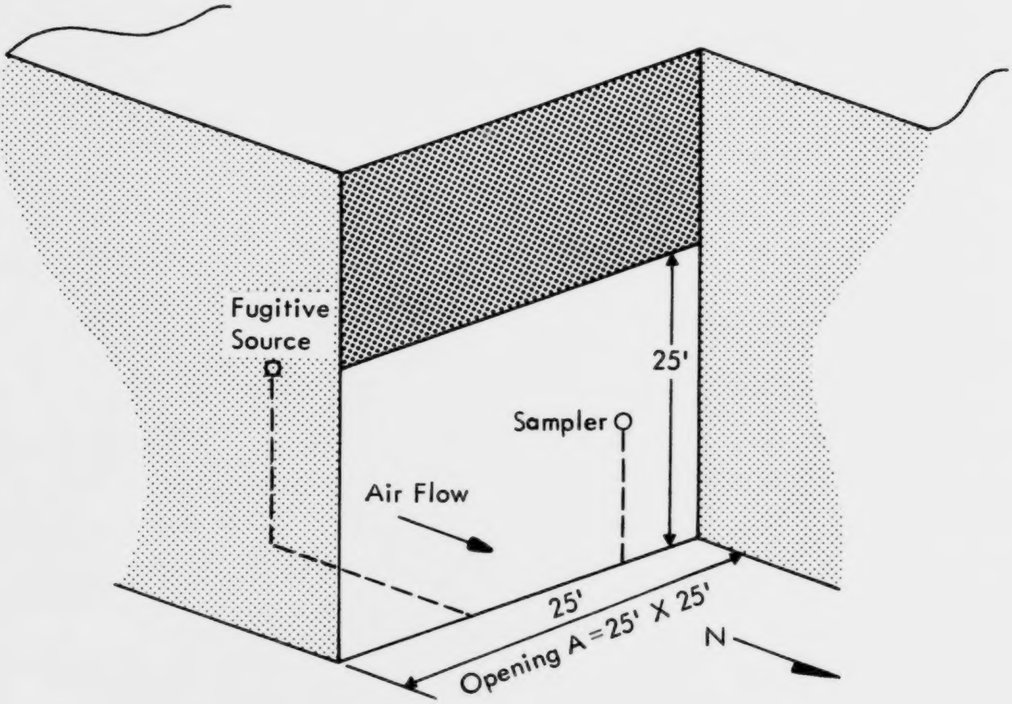
1. Partition the opening into several regions with A_i being the area of the i^{th} region.

2. Assign a fugitive emission profile to the regions based upon the air-flow direction, the air-flow velocity, the location of the fugitive source with respect to the opening, and any other information available that would be pertinent, such as physical aspects of the fugitive emission source, and observations of the flow of the particulates.

3. Calculate an effective area, A_e , based upon the measured concentration of particulates M_m at some point and the emission profile, using formula equations 4 and 4a.

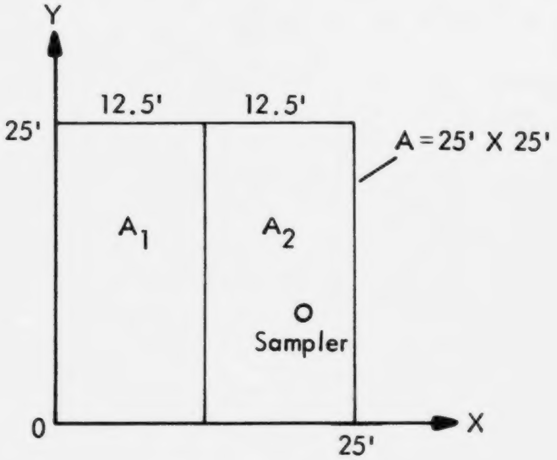
Example

Given:
(1) Situation as shown in accompanying figure.
(2) Area sampled, 25 ft x 25 ft
(3) Wind Direction, 315 degrees
(4) Wind Velocity, 1,000 fpm


Fugitive Source
25'
Sampler
Air Flow
25'
Opening A = 25' X 25'
N

Find: Effective Area, A_e .

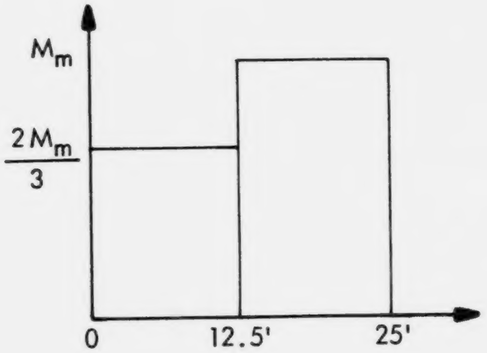
The opening A sampled is illustrated below:



where A_1 is the portion (0.5) of A with an assumed uniform concentration of $\frac{2M_m}{3}$ over A_1, and A_2 is the portion (0.5) of A with an assumed uniform concentration of M_m over A_2 . The basis for the uniformity of concentration over each area and the respective concentrations are based on the observations of the flow of the fugitive particulates from the source, which are, in turn based upon the location of the opening with respect to the source, the size of the opening, the wind velocity and wind direction in the area--source to opening--and physical aspects of the source.

The ordinate (or y-axis of the opening) emission profile is assumed to be uniform vertically for all portions of A .

The abscissa (or x-axis of the opening) emission profile is assumed to be:



Now to calculate the effective area, A_e :

Area of opening $A = 25 \text{ ft} \times 25 \text{ ft} = 625 \text{ sq ft}$
Area of $A_1 = A/2$
Area of $A_2 = A/2$
Emissions from A_1 are 2/3 the emissions from A_2 , i.e.,
$m_1 = 2/3\ m_2 = 2/3\ M_m$.

Therefore, the effective area is:

$$A_e = \frac{\overline{m}}{M_m} A$$

where $\overline{m} = \frac{1}{A} (m_1A_1 + m_2A_2)$

or $\overline{m} = \frac{1}{A} \left[(\frac{2}{3}M_m)\frac{A}{2} + M_m\frac{A}{2} \right]$

$= \frac{5}{6}M_m$

Substituting $\overline{m} = \frac{5}{6} M_m$ in the effective area equation,

$$A_e = \frac{(5/6\ M_m)}{M_m} A$$

$$= \frac{5}{6} A \quad .$$

ASARCO: Glover, Missouri

The sampling locations for which effective areas were calculated are:

1. North end of the Sinter Building.

2. 2N and 2S Roof openings of the Sinter Building.

3. Outside and north of the blast furnace tapping operation.

3A. East of the blast furnace.

4. Inside and north of the charge feed position of the blast furnace.

5. North of the ore storage bin.

The calculations of effective area for each of these are given below.

Sinter Building

Fugitive emissions were sampled at two locations:

Location 1 - (Figures A-1 to A-6, A-8, A-9, and A-12); and
Location 2 - (Figures A-1 to A-5, A-9, A-11, and A-12).

Location 1: There were two samples at this location, namely, Top (1-T) and bottom (1-B). These samplers were run simultaneously using the MRI vertical profile sampler (Figure C-9) at the north end of the Sinter Building. This side of the building had six bay openings, each of which is approximately 32.5 ft x 23.8 ft, and are shown in Figure M-1. A run consisted of traverse sampling of the six bays yielding a composite sample for each of the two sampling elevations. There were four such runs (Runs 1, 2, 3, and 5) providing four samples from the top sampler and four from the bottom sampler. Run 2* was not used in calculating concentrations for Location 1 because the wind was blowing into the building.

Figure M-1 gives the emission profiles assumed in the calculations of the effective areas. For all runs it is assumed that the emissions are distributed uniformly in the horizontal direction across the entire north face of the Sinter Building. The profiles for Runs 1, 3, and 5 are based upon the assumption that bottom sampler results represent the emissions through the bottom third of a bay opening and the top sampler represents the emissions through the remainder of the bay.

The total emission area across the north face is equal to the combined area of the six bays (6 x 32.5 ft x 23.77 ft) or 4,630 sq ft. For Runs 1, 3, and 5, the top and bottom sampler are assumed to represent emission areas in the ratio of 2:1. Therefore, the effective areas for the top and bottom sampler are:

$$A_e \text{ (top)} = \frac{2}{3} \text{ (4,630 sq ft)} = 3{,}090 \text{ sq ft}$$

$$A_e \text{ (bottom)} = \frac{1}{3} \text{ (4,630 sq ft)} = 1{,}540 \text{ sq ft}$$

$$A_e \text{ (total)} = 4{,}630 \text{ sq ft.}$$

Table 9 in the text shows the runs that were used to determine emission rates.

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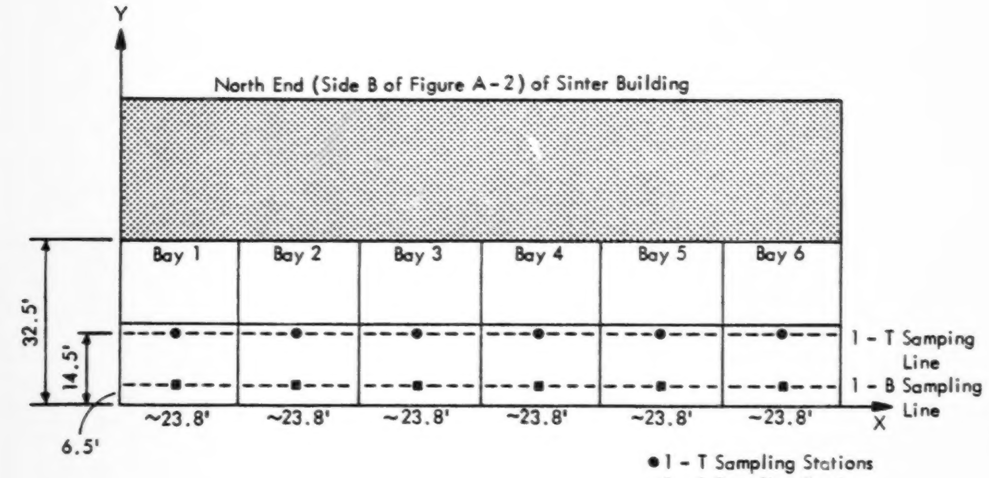
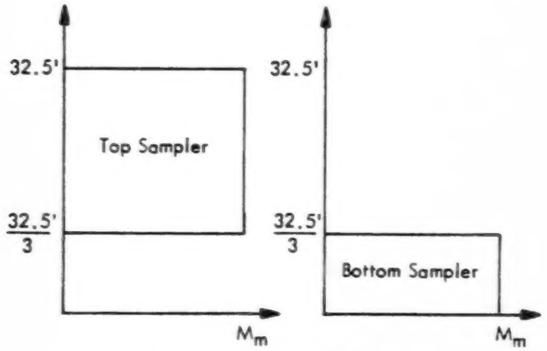
* See page N-2 of Appendix N.


Y
North End (Side B of Figure A-2) of Sinter Building
Bay 1
Bay 2
Bay 3
Bay 4
Bay 5
Bay 6
32.5'
14.5'
6.5'
1 - T Samping Line
1 - B Sampling Line
~23.8'
~23.8'
~23.8'
~23.8'
~23.8'
~23.8'
X
● 1 - T Sampling Stations
■ 1 - B Sampling Stations

Location 1

Runs 1,3 & 5


32.5'
Top Sampler
32.5'/3
M_m
32.5'
32.5'/3
Bottom Sampler
M_m

Particulate Concentration Vertically
Emission Profiles

Figure M-1

Location 2: There were two samplers at this location, namely 2N and 2S. These samplers were run simultaneously at roof openings of the Sinter Building. There are nine roof openings--four are short and five are long. A drawing of these openings is given in Figure M-2 for purposes of explanation in this section. (Figures A-2, A-11, and D-2.) The sinter process equipment is located (Figure A-12) near the east side of the Sinter Building and nearly centered below the small roof openings.

As a consequence of the location of the equipment, emissions are expected to be higher for the eastern portion of the openings than for the emissions from the more westerly portions. For purposes of this analysis, the eastern 42 ft of the openings is considered a high emission area. The assumed north-south relative emission profile (based upon equipment positioning and its emission) for the high-emission openings is plotted in Figure M-2. The average emission value for the remainder (the low emission region) of a long opening (the western 92 ft of length) is assumed to be one-half of the emission value at the high emission portion of the respective opening. The north-south emission profile for this low emission region is also shown in Figure M-2. As the positioning of the two samplers is symmetrical with respect to the roof openings, the area associated with each sample is located on either side of the line drawn through the middle roof opening (opening 5 in Figure M-2).

Given for Runs 1 through 5 (all the runs at these locations)

1. Nine short openings of high emission, each opening 4 ft x 42 ft = A_H = 168 sq ft; and five long openings of low emissions, each opening 4 ft x 92 ft = A_L = 368 sq ft.

2. Area sampled by each sampler, the north sampler and the south sampler, is one-half the total area of the combined nine openings.

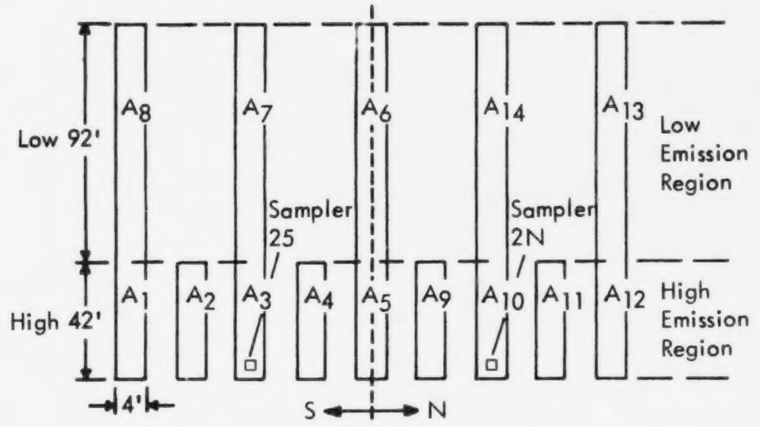
3. The direction of the air flow from within the building at these openings was upward.

The weighted average $\overline{m}$ for the south sampler then becomes:

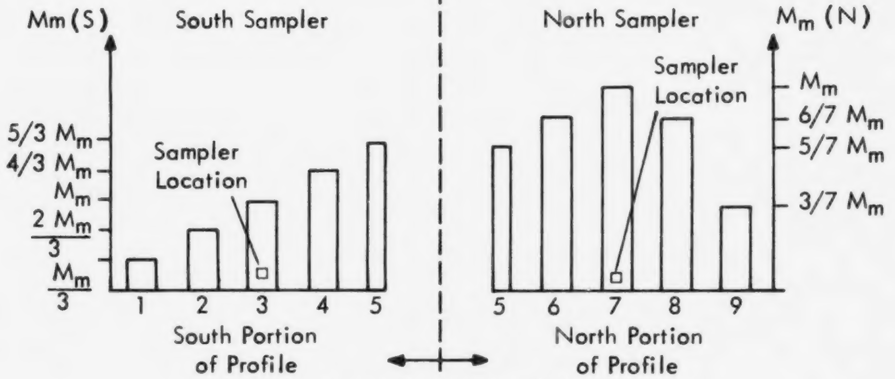
$$\overline{m} = \frac{1}{A_S}\left(m_1A_1 + m_2A_2 + m_3A_3 + m_4A_4 + m_5\frac{A5}{2} + m_6\frac{A6}{2} + m_7A_7 + m_8A_8\right)$$

$$= \frac{1}{A_S}\left[\left(\frac{1}{3}A_1 + \frac{2}{3}A_2 + A_3 + \frac{4}{3}A_4 + \frac{5}{3}\left(\frac{A_5}{2}\right) + \frac{5}{6}\left(\frac{A_6}{2}\right) + \frac{3}{6}A_7 + \frac{1}{6}A_8\right)M_m\right]$$

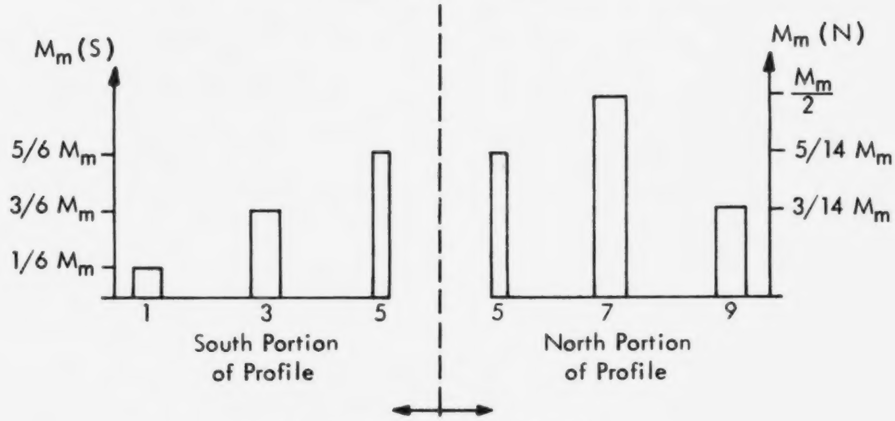
where A_S is the total area of all the openings on the south side.


Low 92'
High 42'
4'
A8
A7
A6
A14
A13
Low Emission Region
Sampler 25
Sampler 2N
A1
A2
A3
A4
A5
A9
A10
A11
A12
High Emission Region
S
N

Location 2
Physical Layout of Roof Openings



North - South Emission Profile
High Emission Region



North - South Emission Profile
Low Emission Region

Figure M-2

But $A_1 = A_2 = A_3 = A_4 = A_5 = A_H$

and $A_6 = A_7 = A_8 = A_L$.

Therefore,

$$\bar{m} = \frac{M_m}{A_S}\left[\frac{25}{6}A_H + \frac{13}{12}A_L\right] .$$

The effective area for the south sampler becomes

$$A_e = \frac{\bar{m}}{M_m} A_S$$

$$A_e = \left[\frac{25}{6}A_H + \frac{13}{12}A_L\right]$$

$$A_e = 1{,}099 \text{ sq ft.}$$

Similarly, for the north sampler,

$$\bar{m} = \frac{M_m}{A_N}\left[\frac{5}{7}\,\frac{A_5}{2} + \frac{6}{7}A_9 + A_{10} + \frac{6}{7}A_{11} + \frac{3}{7}A_{12} + \frac{3}{14}A_{13} + \frac{1}{2}A_{14} + \frac{5}{14}\,\frac{A_6}{2}\right] .$$

But $A_5 = A_9 = A_{10} = A_{11} = A_{12} = A_H$,

and $A_6 = A_{13} = A_{14} = A_L$.

Therefore,

$$\bar{m} = \frac{M_m}{A_N}\left[\frac{49}{14}A_H + \frac{25}{28}A_L\right] \text{ and}$$

$$A_e = \frac{49}{14}A_H + \frac{25}{28}A_L$$

$$A_e = 917 \text{ sq ft.}$$

Blast-Furnace/Dross Operations

This operation was covered by samplers at three different locations. Locations 3, 3A, and 4 (Figures A-1 through A-5).

Location 3: This sampler was positioned on top of an office structure at the northeast opening of the building in which the blast furnace is located (Figure A-5). The opening through which there were fugitive emissions is given in Figure M-3, and for this layout, one is looking to the south.

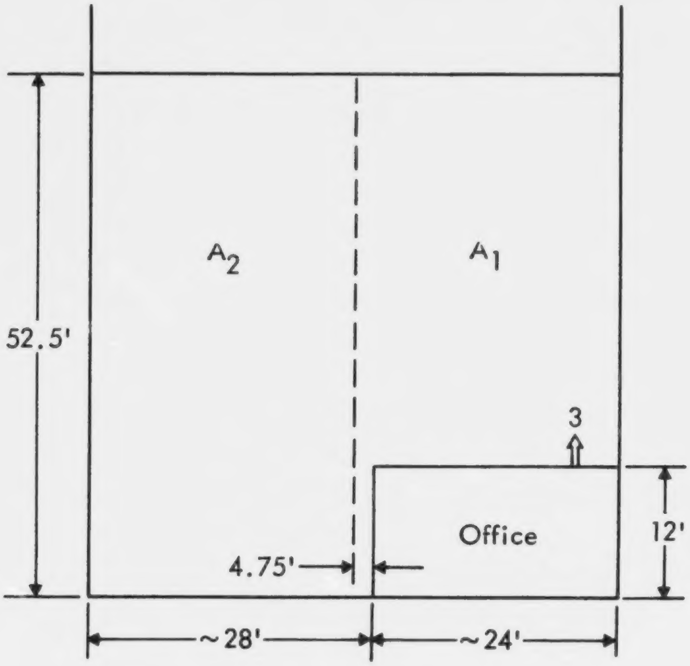


Figure M-3

The area of this opening is:

$$A = A_1 + A_2 = (52.5 \text{ ft} \times 23.25 \text{ ft}) + (40.5 \text{ ft} \times 28.75 \text{ ft} + 12 \text{ ft} \times 4.75 \text{ ft})$$

$$= 1{,}221 + 1{,}221 = 2{,}442 \text{ sq ft},$$

where, $A_1 = A_2 = 0.5A$.

The emissions from A_1 are assumed to be uniform throughout A_1 with a concentration $m_1 = M_m$. The emissions from A_2 are assumed to be uniform throughout A_2 with a concentration of $m_2 = \frac{2}{3} M_m$. The wind direction for Runs 2 through 4 was 135 to 180 degrees and the wind velocity was 245 to 265 fpm. Runs 1 and 5 were not used because there was no flow out of the building toward the sampler at Location 3 (Table 9).

The effective area A_e is determined as follows:

$$\overline{m} = \frac{1}{A}\,(m_1A_1 + m_2A_2)$$

$$\overline{m} = \frac{1}{A}\left[M_m\left(\frac{A}{2}\right) + \left(\frac{2}{3}M_m\right)\left(\frac{A}{2}\right)\right]$$

$$\overline{m} = \frac{5}{6}M_m \quad .$$

Hence, $A_e = \frac{\overline{m}A}{M_m} = \frac{5}{6}A.$

Location 3A: The sampler was located outside the east side of the building (Figures A-5 and A-13). The opening through which there were fugitive emissions is given in Figure M-4, and for this layout, one is looking to the west. The area of the opening is

$$A = A_1 + A_2 + A_3 = 183.75 \text{ ft} \times 52.5 \text{ ft} = 9{,}646 \text{ sq ft}$$

where $A_1 = A_2 = A_3 = 3{,}215$ sq ft.

The emissions from A_1 are assumed to be uniform throughout A_1 with a concentration of $\overline{m}_1 = M_m$. The emissions from A_2 are assumed to be uniform throughout A_2 with a concentration of $\overline{m}_2 = \frac{2\ M_m}{3}$. The emissions from A_3 are assumed to be uniform throughout A_3 with a concentration of $\overline{m}_3 = \frac{M_m}{3}$. The concentrations were proportional in this manner basically by judgment based upon observation of the operations. The wind direction and wind velocity* during sampling back up these assumptions. These judgments on concentrations distribution also take into account the location of the source, its type of operation, etc.

The effective area A_e is determined as follows:

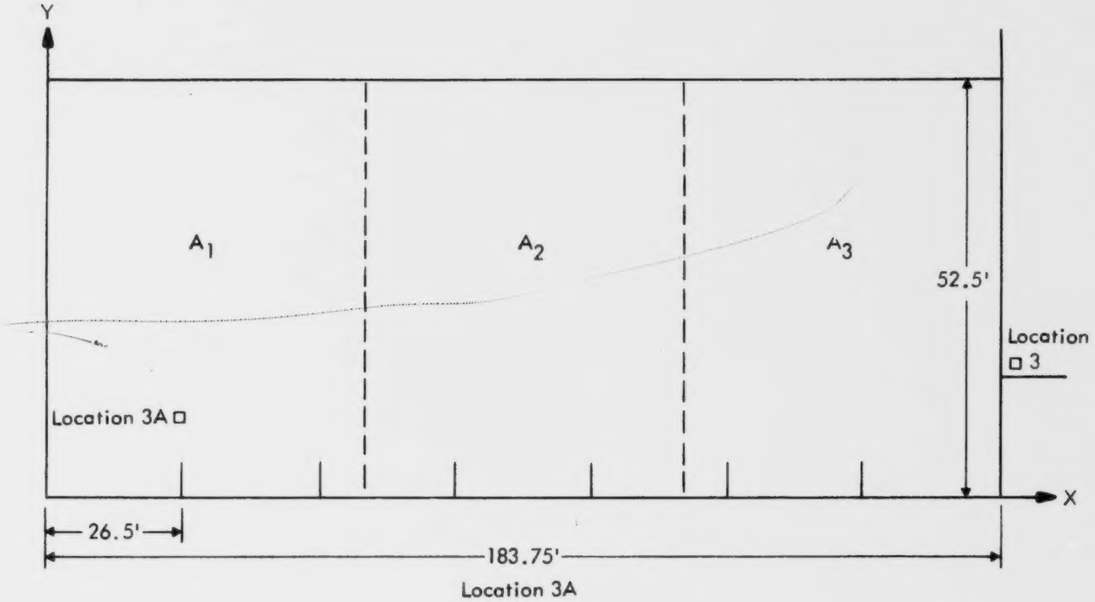
$$\overline{m} = \frac{1}{A}\left[m_1A_1 + m_2A_2 + m_3A_3\right]$$

$$= \frac{1}{A}\left[\left(M_m\right)\left(\frac{A}{3}\right) + \left(\frac{2}{3}M_m\right)\left(\frac{A}{3}\right) + \left(\frac{1}{3}M_m\right)\left(\frac{A}{3}\right)\right]$$

$$= \frac{2}{3}M_m \quad .$$

---

* The wind direction for Runs 3 and 5 was 213 to 327 degrees and the wind velocity was 450 to 500 fpm. Runs 1, 2, and 4 were not used because wind was into the building (Table 9).


Y
A1
A2
A3
52.5'
Location
3
Location 3A
X
26.5'
183.75'
Location 3A

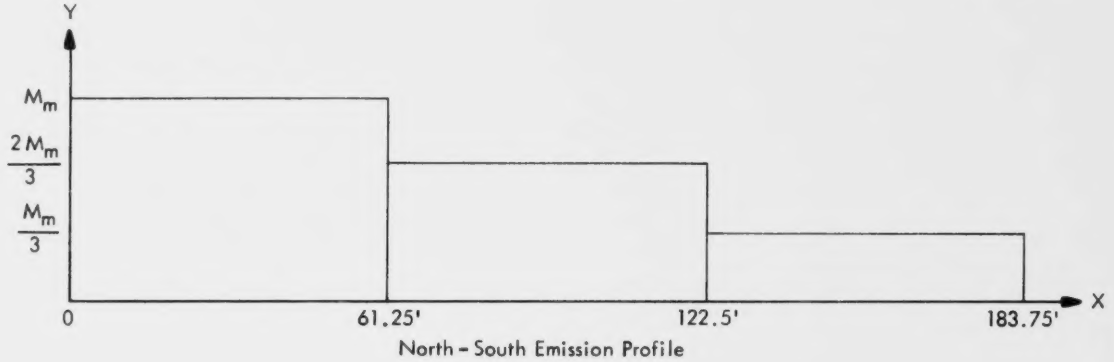

Y
Mm
2 Mm / 3
Mm / 3
X
0
61.25'
122.5'
183.75'
North - South Emission Profile

Figure M-4

Hence, $A_e = \frac{m}{M_m} A$

$= \frac{2}{3} A$.

3. Location 4: This sampler (Figure A-14) sampled emissions from the entire opening (Figure M-5, which is a view looking south). Since the air direction and velocity in the location of this fugitive source were such as to direct the fugitive emissions to the north, and because of the location of the sampler and the geometry of the source and sampling site area, the emissions were assumed to be constant across the entire opening.

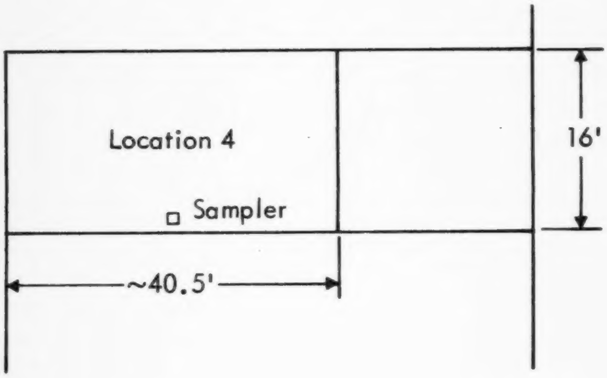


Figure M-5

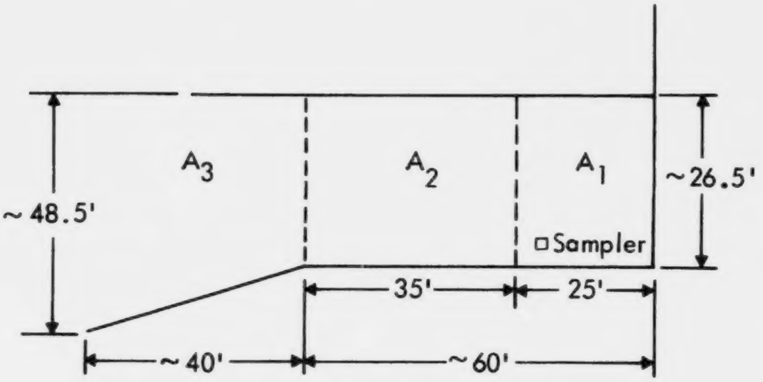
Thus, the area of the entire opening is the effective area or

$A_e = A = 40.5 \text{ ft} \times 16 \text{ ft} = 648 \text{ sq ft}.$

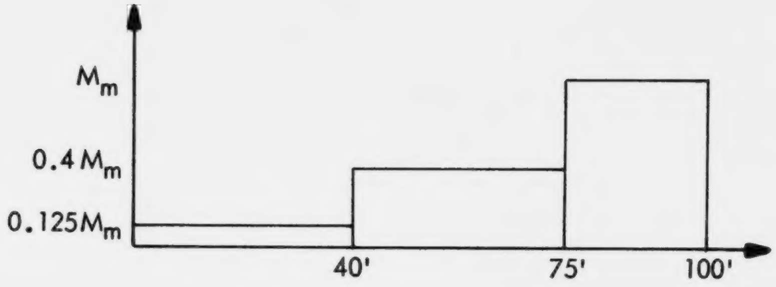
The data from sampling Location 4A were not used because the winds were directed into the building during the time the sampler was operated (see Appendix N, page 5).

Ore Storage Area

The high volume sampler that was at Location 5 (Figures A-1, A-5, and A-15) sampled emissions from the north opening of the building which had dimensions as shown looking south in Figure M-6.



Location 5



Horizontal (East-West) Emission Profile

Figure M-6

The area A of the opening is,

$$A = A_1 + A_2 + A_3 = (25\text{ ft} \times 26.5\text{ ft}) + (35\text{ ft} \times 26.5\text{ ft}) +$$

$$40 \times \left(\frac{26.5\text{ ft} + 48.5\text{ ft}}{2}\right)$$

$$= 662.5 + 927.5 + 1{,}500 = 3{,}090\text{ sq ft.}$$

The emissions from A_1, A_2, and A_3 are assumed to be uniform in the vertical direction. The horizontal profile is given in Figure M-6, where area A_1 has a uniform concentration of $\overline{m}_1 = M_m$ throughout A_1; area A_2 has a uniform concentration of $m_2 = 0.40\ M_m$ throughout A_2; and A_3 has a uniform concentration of $m_3 = 0.125\ M_m$ throughout A_3. The air flow at Location 4 was from the south to the north.

The proportioning of these concentrations by area sector (A_1, A_2, and A_3) was a judgment based upon the location of the sampler with respect to the fugitive source, the physical aspects of the source, the wind direction and wind velocity in the source/sampler area, etc. Since the wind direction at Sampler 5A was directed into the building, the data from that sampler were not used in calculating fugitive emisssions. Effective area calculations were not applicable to Locations 6, 6N, and 6S.

The effective area A_e is determined as follows

$$\overline{m} = \frac{1}{A}\left[m_1A_1 + m_2A_2 + m_3A_3\right]$$

$$= \frac{1}{A}\left[M_mA_1 + 0.4\ M_m\ A_2 + 0.125\ M_m\ A_3\right]$$

$$A_e = A_1 + 0.4\ A_2 + 0.125\ A_3$$

$$= 662.5 + 0.4\ (927.5) + 0.125\ (1{,}500)$$

$$= 1{,}220 \text{ sq ft.}$$

ASARCO, East Helena, Montana

As the openings in the buildings of the Helena plant were smaller than those of the Glover plant, no effective area calculations were made. Emissions were assumed constant across an opening. In most cases, the entire opening area was used in the emission computations. For Locations 13, 14, and 14A, it was assumed that one-half of the windows would be closed by shutters so only half the opening area was used. For Locations 17 and 18 only one of the two openings (each 5 ft x 120 ft) was used since the samplers were placed on the downwind side. Each of these sampler locations covered a 5 ft x 60 ft opening, or one-half of the total. For Location 21, an area 9 ft by 14 ft was excluded from the opening area to account for that space taken up by a railroad car. The area of the platform (3 ft x 2 ft) was excluded from the stack area on Location 23.

Location 11
Area = 4 (6 ft) (10 ft) = 240 sq ft

Location 12
Area = (π) (0.75 sq ft) = 1.8 sq ft

Location 13 (windows)

$$\text{Area} = \frac{(4\text{ ft})\ (12\text{ ft}) + (4\text{ ft})\ (16\text{ ft})\ (2) + (4\text{ ft})\ (13\text{ ft})}{2} = 114 \text{ sq ft}$$

Location 14 (windows)

$$\text{Area} = \frac{2\ (4\ \text{ft})\ (28.5\ \text{ft})}{2} = 114\ \text{sq ft}$$

Location 14A (windows)

$$\text{Area} = \frac{(4\ \text{ft})\ (37\ \text{ft})}{2} = 74\ \text{sq ft}$$

Location 15

Area = (4 ft) (6 ft) (2) = 48 sq ft

Location 16

Area = (4 ft) (16 ft) = 64 sq ft

Locations 17 and 18

Area = (5 ft) (60 ft) = 300 sq ft (each)

Location 19

Area = (12 ft) (40 ft) = 480 sq ft

Location 20

Area = (3 ft) (10 ft) = 30 sq ft

Location 21

Area = (17 ft) (15 ft) - (14 ft) (9 ft) = 129 sq ft

Location 22

Area = (12 ft) (15 ft) = 180 sq ft

Location 23

Area = (20 ft) (11 ft) - (3 ft) (2 ft) = 214 sq ft

Effective area calculations were not applicable to Locations 23A, 24N, and 24S because they were sampling the ambient air.

APPENDIX N

EMISSION RATE CALCULATIONS FOR TOTAL PARTICULATE, LEAD AND ARSENIC

		Concentration[a/] (μg/m³)				Effective	Wind		
Location	Run	Total Part.	Pb	As	Flow (fpm)	Area (sq ft)	Dir. (deg.)	Vel. (fpm)	Remarks
1-top	1	2,090	939	0.48	25	3,090	337	265	1-top, 1-bottom and 1 conc. values of Run 2 not used because of wind direction.
1-top	2	4,270	687	1.10	90	2,315	360	90	
1-top	3	6,770	3,000	2.36	67.5	3,090	135	175	
1-top	5	356	-	-	275	3,090	337	265	
1-bottom	1	11,100	-	-	25	1,540	337	265	
1-bottom	2	3,190	666	0.74	90	2,315	360	90	
1-bottom	3	8,370	2,740	2.44	67.5	1,540	135	175	
1-bottom	5	451	-	-	275	1,540	337	265	
1	1	6,370	-	-	25	1,540	360	265	
1	2	1,440	-	-	90	2,315	360	90	
2-north	1	3,370	2,010	0.96	125	945	337	265	All conc. values used in emission rate calculations.
2-north	2	11,200	1,120	2.43	125	945	360	90	
2-north	3	2,150	1,250	0.58	125	945	135	175	
2-north	4	16,700	-	-	125	945	157	265	
2-north	5	14,300	-	-	125	945	337	210	
2-south	1	2,960	1,560	0.92	225	485	337	265	
2-south	2	5,040	502	1.52	225	485	360	90	
2-south	3	3,090	-	-	225	485	135	175	
2-south	4	5,810	1,050	1.74	225	485	157	265	
2-south	5	8,230	1,220	2.23	225	485	337	210	

[a/] Standard conditions.

Total Particulates:

Location	Run	Emission Rate in mg/min	
1-top	1	$E = 2,090 \times 25 \times 3,090 \times 0.028317 \times 10^{-3}$	= 4,570
1-top	3	$E = 6,770 \times 67.5 \times 3,090 \times 0.028317 \times 10^{-3}$	= 40,000
1-top	5	$E = 356 \times 275 \times 3,090 \times 0.028317 \times 10^{-3}$	= 8,570
1-bottom	1	$E = 11,100 \times 25 \times 1,540 \times 0.028317 \times 10^{-3}$	= 12,100
1-bottom	3	$E = 8,370 \times 67.5 \times 1,540 \times 0.028317 \times 10^{-3}$	= 24,600
1-bottom	5	$E = 451 \times 275 \times 1,540 \times 0.028317 \times 10^{-3}$	= 5,410
1	1	$E = 6,370 \times 25 \times 1,540 \times 0.028317 \times 10^{-3}$	= 6,940
			102,000

E_1 = 14,600 mg/min

Location	Run	Emission Rate in mg/min	
2-north	1	$E = 3{,}370 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 11,300
2-north	2	$E = 11{,}200 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 37,500
2-north	3	$E = 2{,}150 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 7,190
2-north	4	$E = 16{,}700 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 55,900
2-north	5	$E = 14{,}300 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 47,800
2-south	1	$E = 2{,}960 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 9,150
2-south	2	$E = 5{,}040 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 15,600
2-south	3	$E = 3{,}090 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 9,550
2-south	4	$E = 5{,}810 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 18,000
2-south	5	$E = 8{,}230 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 25,400
			237,000

$$E_2 = 23{,}700 \text{ mg/min}$$

Emission rate from sinter building is

$$E_{SB} = E_1 + E_2 = 14{,}600 + 23{,}700$$

$$= 38{,}300 \text{ mg/min}$$

An emission rate can be converted as follows:

$$E_{SB} = \frac{38{,}300 \text{ (mg/min)} \times 60}{10^6 \text{ (mg/kg)}} = 2.30 \text{ kg/hr}$$

$$E_{SB} = 2.30 \text{ (kg/hr)} \times 24 = 55.2 \text{ kg/day,}$$

$$E_{SB} = 2.30 \text{ (kg/hr)} \times 2.2046 = 5.07 \text{ lb/hr, and}$$

$$E_{SB} = 5.07 \text{ (lb/hr)} \times 24 = 122 \text{ lb/day,}$$

where 2.2046 is the factor to convert kg to lb.

Lead:

Location	Run		
1-top	1	$E = 939 \times 25 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 2,050
1-top	3	$E = 3{,}000 \times 67.5 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 17,700
1-bottom	3	$E = 2{,}740 \times 67.5 \times 1{,}540 \times 0.028317 \times 10^{-3}$	= 8,060
			27,800

$$E_1 = 9{,}270 \text{ mg/min}$$

Lead:

Location	Run		
2-north	1	$E = 2{,}010 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 6,720
2-north	2	$E = 1{,}120 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 3,750
2-north	3	$E = 1{,}250 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 4,180
2-south	1	$E = 1{,}560 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 4,820
2-south	2	$E = 502 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 1,550
2-south	4	$E = 1{,}050 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 3,240
2-south	5	$E = 1{,}220 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 3,770
			28,000

$$E_2 = 4{,}000 \text{ mg/min}$$

Lead

$$E_{\text{Sinter Building}} = 9{,}270 + 4{,}000 = 13{,}300 \text{ mg/min}$$

Arsenic:

Location	Run		
1-top	1	$E = 0.48 \times 25 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 1.05
1-top	3	$E = 2.36 \times 67.5 \times 3{,}090 \times 0.028317 \times 10^{-3}$	= 13.9
1-bottom	3	$E = 2.44 \times 67.5 \times 1{,}540 \times 0.028317 \times 10^{-3}$	= 7.18
			22.1

$$E_1 = 7.37 \text{ mg/min}$$

Arsenic:

Location	Run		
2-north	1	$E = 0.96 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 3.21
2-north	2	$E = 3.71 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 12.4
2-north	3	$E = 0.58 \times 125 \times 945 \times 0.028317 \times 10^{-3}$	= 1.94
2-south	1	$E = 0.92 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 2.84
2-south	2	$E = 1.52 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 4.70
2-south	4	$E = 1.74 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 5.38
2-south	5	$E = 2.23 \times 225 \times 485 \times 0.028317 \times 10^{-3}$	= 6.89
			37.4

$$E_2 = 5.34 \text{ mg/min}$$

Arsenic:

$$E_{\text{Sinter Building}} = 7.37 + 5.34 = 12.7 \text{ mg/min}$$

		Concentration[a/] (µg/m³)				Effective	Wind		
Location	Run	Total Part.	Pb	As	Flow (fpm)	Area (sq ft)	Dir. (deg.)	Vel. (fpm)	Remarks
3	1	1,920	917	1.84	0	2,035	-	Calm	Runs 1 and 5 conc. values not used because of no flow out of bldg. opening
3	2	634	-	-	245	2,035	180	245	
3	3	715	351	0.53	265	2,035	180	265	
3	4	257	139	0.11	265	2,035	135	265	
3	4	377	184	0.22	265	2,035	135	265	
3	5	2,259	-	-	175	2,035	360	175	
3A	1	399	-	-	215	6,430	57	215	Runs 1, 2 and 4 conc. values not used because winds into bldg.
3A	2	158	60.2	0.047	190	6,430	113	190	
3A	3	412	252	0.74	500	6,430	213	500	
3A	4	153	53.3	0.084	360	6,430	152	360	
3A	5	306	118	0.71	450	6,430	327	450	
4	6	9,770	-	-	10	650	-	Calm	All conc. values used.
4	7	4,450	1,840	1.65	10	650	-	Calm	
4	8	2,080	1,320	0.55	10	650	-	Calm	
4	9	1,160	586	0.23	10	650	-	Calm	
4	10	7,120	2,040	1.50	10	650	-	Calm	
4	11	1,100	-	-	10	650	-	Calm	
4A	12	270	-	-	10	Amb.	225	300	Not used because wind directed into building.

[a/] Standard conditions.

Total Particulates:

Location	Run		
3	2	$E = 634 \times 245 \times 2{,}035 \times 0.028317 \times 10^{-3}$	= 8,950
3	3	$E = 715 \times 265 \times 2{,}035 \times 0.028317 \times 10^{-3}$	= 10,900
3	4	$E = 257 \times 265 \times 2{,}035 \times 0.028317 \times 10^{-3}$	= 3,920
3	4	$E = 377 \times 265 \times 2{,}035 \times 0.028317 \times 10^{-3}$	= 5,760
			29,500

$E_3 = 7{,}380$ mg/min

Location	Run		
3A	3	$E = 412 \times 500 \times 6430 \times 0.028317 \times 10^{-3}$	= 37,500
3A	5	$E = 306 \times 450 \times 6430 \times 0.028317 \times 10^{-3}$	= 25,100
			58,700

$E_{3A} = 31{,}300$ mg/min

(Take 10% going out of bldg. for Location 4 since sampler was located within bldg.)

Location	Run		
4	6	$E = 9{,}770 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 1,800
4	7	$E = 4{,}450 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 819
4	8	$E = 2{,}080 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 383
4	9	$E = 1{,}160 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 214
4	10	$E = 7{,}120 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 1,310
4	11	$E = 1{,}100 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 202
			4,730

$$10\%\ E_4 = \frac{788}{10} = 78.8 \text{ mg/min}$$

Emission from Blast Furnace/Dross Kettle:

$$E_{BF/DK} = E_3 + E_{3A} + 0.10\ E_4$$

$$= 7{,}380 + 31{,}300 + 78.8$$

$$= 38{,}800 \text{ mg/min}$$

Lead - ER:

Location	Run		
3	3	$E = 351 \times 265 \times 2035 \times 0.028317 \times 10^{-3}$	= 5,360
3	4	$E = 139 \times 265 \times 2035 \times 0.028317 \times 10^{-3}$	= 2,120
3	4	$E = 184 \times 265 \times 2035 \times 0.028317 \times 10^{-3}$	= 2,810
			10,300

$E_3 = 3{,}430$ mg/min

Lead

Location	Run	
3A	3	$E = 252 \times 500 \times 6{,}430 \times 0.028317 \times 10^{-3} = 22{,}900$
3A	5	$E = 118 \times 450 \times 6{,}430 \times 0.028317 \times 10^{-3} = \underline{9{,}670}$
		32,600

$$E_{3A} = 16{,}300 \text{ mg/min}$$

Lead (take 10% of sample as going out of building)

Location	Run	
4	7	$E = 1{,}840 \times 10 \times 650 \times 0.028317 \times 10^{-3} = 339$
4	8	$E = 1{,}320 \times 10 \times 650 \times 0.028317 \times 10^{-3} = 243$
4	9	$E = 586 \times 10 \times 650 \times 0.028317 \times 10^{-3} = 108$
4	10	$E = 2{,}040 \times 10 \times 650 \times 0.028317 \times 10^{-3} = \underline{375}$
		1,060

$$10\%\ E_4 = \frac{1{,}060}{4 \times 10} = 265 \text{ mg/min} \times 0.10 = 26.5 \text{ mg/min}$$

$$E_{BF/DK} = E_3 + E_{3A} + E_4$$

$$= 3{,}430 + 16{,}300 + 26.5 = 19{,}800 \text{ mg/min}$$

Arsenic:

Location	Run	
3	3	$E = 0.53 \times 265 \times 2{,}035 \times 0.028317 \times 10^{-3} = 8.09$
3	4	$E = 0.11 \times 265 \times 2{,}035 \times 0.028317 \times 10^{-3} = 1.68$
3	4	$E = 0.22 \times 265 \times 2{,}035 \times 0.028317 \times 10^{-3} = \underline{3.36}$
		13.1

$$E_3 = 4.37 \text{ mg/min}$$

Arsenic:

Location	Run	
3A	3	$E = 0.74 \times 500 \times 6{,}430 \times 0.028317 \times 10^{-3} = 67.4$
3A	5	$E = 0.71 \times 450 \times 6{,}430 \times 0.028317 \times 10^{-3} = \underline{58.2}$
		126

$$E_3 = 63.0 \text{ mg/min}$$

Arsenic:

Location	Run		
4	7	$E = 1.65 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 0.304
4	8	$E = 0.55 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 0.101
4	9	$E = 0.23 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 0.043
4	10	$E = 1.50 \times 10 \times 650 \times 0.028317 \times 10^{-3}$	= 0.276
			0.724

$E_4 = 0.181$ mg/min $\times\ 0.10 = 0.018$

$E_{BF/DK} = E_3 + E_{3A} + E_4$

$= 4.37 + 63.0 + 0.018 = 67.4$ mg/min

Location	Run	Concentration[a] (μg/m³)			Flow (fpm)	Effective Area (sq ft)	Wind		Remarks
		Total Part.	Pb	As			Dir. (deg.)	Vel. (fpm)	
5	6	214	104	0.049	165	1,190	225	165	Runs 6, 8, and 10 conc. value not used because wind was directed into bldg.
5	7	270	-	-	310	1,190	135	310	
5	8	91	-	-	230	1,190	324	230	
5	9	197	100	0.048	360	1,190	176	360	
5	10	774	166	-	510	1,190	225	510	
5	10	114	30.8	0.019	165	1,190	360	165	
5A	12	885	-	-	245	-	247	245	Not used because wind directed into bldg.

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[a] Standard conditions.

(No calculations for 6, 6N, and 6S.)

Location	Run	Concentration[a] (μg/m³)			Flow (fpm)	Effective Area (sq ft)	Wind		Remarks
		Total Part.	Pb	As			Dir. (deg.)	Vel. (fpm)	
6-overpass	8	854	102	0.12	200	-	225	200	6, 6N, and 6S gave only ambient background conc.; thus no emissions were calculable.
6-overpass	10	296	139	0.060	160	-	180	160	
6-overpass	12	405	117	0.055	255	-	225	255	
6-north	8	139	-	-	200	-	225	200	
6-north	10	3,080	114	0.19	160	-	180	160	
6-north	12	162	-	-	350	-	225	350	
6-north	12	175	22.8	0.014	225	-	225	255	
6-south	8	252	-	-	200	-	225	200	
6-south	10	79.3	6.60	0.005	160	-	180	160	
6-south	12	112	16.7	0.011	225	-	225	255	

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[a] Standard conditions.

Total Particulates:

Location	Run	Emission Rate in mg/min
5	7	$E = 270 \times 310 \times 1{,}190 \times 0.028317 \times 10^{-3} = 2{,}820$
5	9	$E = 197 \times 360 \times 1{,}190 \times 0.028317 \times 10^{-3} = \underline{2{,}390}$
		$5{,}210$

$E_5 = 2{,}600$ mg/min

$E_{OSB} = E_5 = 2{,}600$ mg/min

Lead:

Location	Run	Emission Rate in mg/min
5	9	$E = 100 \times 360 \times 1{,}190 \times 0.028317 \times 10^{-3} = 1{,}210$

$E_{OSB} = E_5 = 1{,}210$ mg/min

Arsenic:

Location	Run	Emission Rate in mg/min
5	9	$E = 0.048 \times 360 \times 1{,}190 \times 0.028317 \times 10^{-3} = 0.582$

$E_{OSB} = E_5 = 0.582$ mg/min

Location	Run	Concentration[a] ($\mu g/m^3$) Total Part.	Pb	As	Flow (fpm)	Effective Area (sq ft)	Wind Dir. (deg.)	Wind Vel. (fpm)	Remarks
11	20	6,620	541	48.7	275 (v)	240	240	620	All conc. values for Runs 11 to 16 were used.
11	21	10,700	-	-	225 (v)	240	65	705	
11	22	3,130	-	-	100 (v)	240	192	995	
12	20	4,120	753	106	275 (v)	1.8	240	620	
12	21	5,150	-	-	75 (v)	1.8	65	705	
12	22	3,730	296	20.6	300 (b)	1.8	192	995	
13	20	15,700	734	82.3	275	114	240	620	
13	21	1,740	-	-	270	114	Var.	705	
13	22	6,050	498	25.8	300	114	192	995	
14	20	3,340	221	22.1	275 (v)	114	240	620	
14	21	1,100	-	-	100 (v)	114	Var.	705	
14A	22	3,010	256	10.9	50	74	192	995	
15	20	2,610	383	12.5	275 (v)	48	240	620	
15	21	3,090	-	-	150 (v)	48	Var.	705	
15	22	3,930	904	22.2	250 (v)	48	192	995	
16	20	7,220	416	32.1	50 (v)	64	240	620	
16	21	2,730	-	-	250 (v)	64	Var.	705	
16	22	684	131	2.99	300 (v)	64	192	995	

---

[a] Standard conditions.

Location	Run	
11	20	$E = 6{,}620 \times 275 \times 240 \times 0.028317 \times 10^{-3} = 12{,}400$
11	21	$E = 10{,}700 \times 225 \times 240 \times 0.028317 \times 10^{-3} = 16{,}400$
11	22	$E = 3{,}130 \times 100 \times 240 \times 0.028317 \times 10^{-3} = \underline{2{,}130}$
		30,900

E_{11} = 10,300 mg/min

Location	Run	
12	20	$E = 4{,}120 \times 275 \times 1.8 \times 0.028317 \times 10^{-3} = 57.8$
12	21	$E = 5{,}150 \times 75 \times 1.8 \times 0.028317 \times 10^{-3} = 19.7$
12	22	$E = 3{,}730 \times 300 \times 1.8 \times 0.028317 \times 10^{-3} = \underline{57.0}$
		134.5

E_{12} = 44.8 mg/min

Location	Run		
13	20	$E = 15{,}700 \times 275 \times 114 \times 0.028317 \times 10^{-3}$	= 13,900
13	21	$E = 1{,}740 \times 270 \times 114 \times 0.028317 \times 10^{-3}$	= 1,520
13	22	$E = 6{,}050 \times 300 \times 114 \times 0.028317 \times 10^{-3}$	= 5,860
			21,300

$E_{13} = 7{,}100$ mg/min

Location	Run		
14	20	$E = 3{,}340 \times 275 \times 114 \times 0.028317 \times 10^{-3}$	= 2,960
14	21	$E = 1{,}100 \times 100 \times 114 \times 0.028317 \times 10^{-3}$	= 355
14	22	$E = 3{,}010 \times 50 \times 74 \times 0.028317 \times 10^{-3}$	= 315
			3,630

$E_{14} = 1{,}210$ mg/min

Location	Run		
15	20	$E = 2{,}610 \times 275 \times 48 \times 0.028317 \times 10^{-3}$	= 976
15	21	$E = 3{,}090 \times 150 \times 48 \times 0.028317 \times 10^{-3}$	= 630
15	22	$E = 3{,}930 \times 250 \times 48 \times 0.028317 \times 10^{-3}$	= 1,340
			2,950

$E_{15} = 983$ mg/min

Location	Run		
16	20	$E = 7{,}220 \times 50 \times 64 \times 0.028317 \times 10^{-3}$	= 654
16	21	$E = 2{,}730 \times 250 \times 64 \times 0.028317 \times 10^{-3}$	= 1,240
16	22	$E = 684 \times 300 \times 64 \times 0.028317 \times 10^{-3}$	= 372
			2,270

$E_{16} = 757$ mg/min

$$E_{\text{Sinter Building}} = E_{11} + E_{12} + E_{13} + E_{14} + E_{15} + E_{16}$$

$$= 10{,}300 + 44.8 + 7{,}100 + 1{,}210 + 983 + 757$$

$$= 20{,}400 \text{ mg/min}$$

Lead:

Location	Run	
11	20	$E = 541 \times 275 \times 240 \times 0.028317 \times 10^{-3} = 1{,}010$ mg/min

$E_{11} = 1{,}010$ mg/min

Lead

Location	Run	
12	20	$E = 753 \times 275 \times 1.8 \times 0.028317 \times 10^{-3} = 10.6$
12	22	$E = 296 \times 300 \times 1.8 \times 0.028317 \times 10^{-3} = \underline{4.53}$
		15.1

$E_{12} = 7.55$ mg/min

Lead:

Location	Run	
13	20	$E = 734 \times 275 \times 114 \times 0.028317 \times 10^{-3} = 652$
13	22	$E = 498 \times 300 \times 114 \times 0.028317 \times 10^{-3} = \underline{482}$
		1,130

$E_{13} = 565$ mg/min

Lead:

Location	Run	
14	20	$E = 221 \times 275 \times 114 \times 0.028317 \times 10^{-3} = 196$
14A	22	$E = 256 \times 50 \times 74 \times 0.028317 \times 10^{-3} = \underline{26.8}$
		223

$E_{14} = 112$ mg/min

Lead:

Location	Run	
15	20	$E = 360 \times 275 \times 48 \times 0.028317 \times 10^{-3} = 134$
15	22	$E = 904 \times 250 \times 48 \times 0.028317 \times 10^{-3} = \underline{307}$
		441

$E_{15} = 220$ mg/min

Lead:

Location	Run	
16	20	$E = 416 \times 50 \times 64 \times 0.028317 \times 10^{-3} = 38.0$
16	22	$E = 131 \times 300 \times 64 \times 0.028317 \times 10^{-3} = \underline{71.2}$
		109

$E_{16} = 54.5$ mg/min

$$E_{\text{Sinter Building}} = E_{11} + E_{12} + \ldots + E_{16}$$
$$= 1{,}010 + 7.55 + 565 + 112 + 220 + 54.5 = 1{,}970 \text{ mg/min}$$

Arsenic:

Location	Run	
11	20	$E = 48.7 \times 275 \times 240 \times 0.028317 \times 10^{-3} = 91.0$ mg/min

$E_{11} = 91.0$ mg/min

Arsenic:

Location	**Run**	
12	20	$E = 106 \times 275 \times 1.8 \times 1.8 \times 0.028317 \times 10^{-3} = 1.48$
12	22	$E = 20.6 \times 300 \times 1.8 \times 1.8 \times 0.028317 \times 10^{-3} = \underline{0.32}$
		1.80

$$E_{12} = 0.90 \text{ mg/min}$$

Arsenic:

Location	**Run**	
13	20	$E = 82.3 \times 275 \times 114 \times 0.028317 \times 10^{-3} = 73.1$
13	22	$E = 25.8 \times 300 \times 114 \times 0.028317 \times 10^{-3} = \underline{25.0}$
		98.1

$$E_{13} = 49.0 \text{ mg/min}$$

Arsenic:

Location	**Run**	
14	20	$E = 22.1 \times 275 \times 114 \times 0.028317 \times 10^{-3} = 19.6$
14A	22	$E = 10.9 \times 50 \times 74 \times 0.028317 \times 10^{-3} = \underline{1.14}$
		20.7

$$E_{14} = 10.4 \text{ mg/min}$$

Arsenic:

Location	**Run**	
15	20	$E = 12.5 \times 275 \times 48 \times 0.028317 \times 10^{-3} = 4.67$
15	22	$E = 22.2 \times 250 \times 48 \times 0.028317 \times 10^{-3} = \underline{7.54}$
		12.2

$$E_{15} = 6.10 \text{ mg/min}$$

Arsenic:

Location	**Run**	
16	20	$E = 32.1 \times 50 \times 64 \times 0.028317 \times 10^{-3} = 2.91$
16	22	$E = 2.99 \times 300 \times 64 \times 0.028317 \times 10^{-3} = \underline{1.62}$
		4.53

$$E_{16} = 2.26 \text{ mg/min}$$

$$E_{\text{Sinter Building}} = E_{11} + \ldots\ldots + E_{16}$$

$$= 91 + 0.90 + 49 + 10.4 + 6.10 + 2.26 = 160 \text{ mg/min}$$

		Concentration[a/] (μg/m³)				Effective	Wind		
Location	Run	Total Part.	Pb	As	Flow (fpm)	Area (sq ft)	Dir. (deg.)	Vel. (fpm)	Remarks
17	27	988	223	65.4	975	600	315	975	Use all conc. values.
17	28	1,540	-	-	810	600	209	810	
17	29	1,200	-	-	975	600	230	975	
17	30	3,500	816	286	420	600	322	420	
17	31	3,360	-	-	580	600	360	580	
17	32	7,070	912	596	1,125	600	275	1,125	
17	33	3,260	1,000	301	535	600	338	535	
18	27	1,170	282	56.1	975	600	315	975	Use all conc. values.
18	28	1,230	-	-	810	600	225	810	
18	29	3,150	-	-	975	600	230	975	
18	30	6,150	-	-	420	600	322	420	
18	31	1,830	-	-	580	600	360	580	
18	32	10,400	1,140	691	1,125	600	275	1,125	
18	33	3,490	1,060	176	535	600	338	535	

[a/] Standard conditions.

Total Particulate:

Location	Run	
17	27	$E = 988 \times 975 \times 600 \times 0.02831 \times 10^{-3} = 16{,}400$
17	28	$E = 1{,}540 \times 810 \times 600 \times 0.02831 \times 10^{-3} = 21{,}200$
17	29	$E = 1{,}200 \times 975 \times 600 \times 0.02831 \times 10^{-3} = 19{,}900$
17	30	$E = 3{,}500 \times 420 \times 600 \times 0.02831 \times 10^{-3} = 25{,}000$
17	31	$E = 3{,}360 \times 580 \times 600 \times 0.02831 \times 10^{-3} = 33{,}100$
17	32	$E = 7{,}070 \times 1{,}125 \times 600 \times 0.02831 \times 10^{-3} = 135{,}000$
17	33	$E = 3{,}260 \times 535 \times 600 \times 0.02831 \times 10^{-3} = 29{,}600$
		280,000

$$E_{17} = 40{,}000 \text{ mg/min}$$

Location	Run	
18	27	$E = 1{,}170 \times 975 \times 600 \times 0.02831 \times 10^{-3} = 19{,}400$
18	28	$E = 1{,}230 \times 810 \times 600 \times 0.02831 \times 10^{-3} = 16{,}900$
18	29	$E = 3{,}150 \times 975 \times 600 \times 0.02831 \times 10^{-3} = 52{,}200$
18	30	$E = 6{,}150 \times 420 \times 600 \times 0.02831 \times 10^{-3} = 43{,}900$
18	31	$E = 1{,}830 \times 580 \times 600 \times 0.02831 \times 10^{-3} = 18{,}000$
18	32	$E = 10{,}400 \times 1{,}125 \times 600 \times 0.02831 \times 10^{-3} = 199{,}000$
18	33	$E = 3{,}490 \times 535 \times 600 \times 0.02831 \times 10^{-3} = 31{,}700$
		381,000

$$E_{18} = 54{,}400 \text{ mg/min}$$

$$E_{\text{Dross/Reverb}} = E_{17} + E_{18} = 40{,}000 + 54{,}400 = 94{,}400 \text{ mg/min}$$

Lead:

Location	Run		
17	27	$E = 223 \times 975 \times 600 \times 0.028317 \times 10^{-3}$	= 3,690
17	30	$E = 816 \times 420 \times 600 \times 0.028317 \times 10^{-3}$	= 5,820
17	32	$E = 912 \times 1,125 \times 600 \times 0.028317 \times 10^{-3}$	= 17,400
17	33	$E = 1,000 \times 535 \times 600 \times 0.028317 \times 10^{-3}$	= 9,090
			36,000

$$E_{17} = 9,000 \text{ mg/min}$$

Lead:

Location	Run		
18	27	$E = 282 \times 975 \times 600 \times 0.028317 \times 10^{-3}$	= 4,670
18	32	$E = 1,140 \times 1,125 \times 600 \times 0.028317 \times 10^{-3}$	= 21,800
18	33	$E = 1,060 \times 535 \times 600 \times 0.028317 \times 10^{-3}$	= 9,640
			36,100

$$E_{18} = 12,000 \text{ mg/min}$$

$$E_{\text{Dross/Reverb}} = 9,000 + 12,000 = 21,000 \text{ mg/min}$$

Arsenic:

Location	Run		
17	27	$E = 65.4 \times 975 \times 600 \times 0.028317 \times 10^{-3}$	= 1,080
17	30	$E = 286 \times 420 \times 600 \times 0.028317 \times 10^{-3}$	= 2,040
17	32	$E = 596 \times 1,125 \times 600 \times 0.028317 \times 10^{-3}$	= 11,400
17	33	$E = 301 \times 535 \times 600 \times 0.028317 \times 10^{-3}$	= 2,740
			17,300

$$E_{17} = 4,320 \text{ mg/min}$$

Arsenic:

Location	Run		
18	27	$E = 56.1 \times 975 \times 600 \times 0.028317 \times 10^{-3}$	= 929
18	32	$E = 691 \times 1,125 \times 600 \times 0.028317 \times 10^{-3}$	= 13,200
18	33	$E = 176 \times 535 \times 600 \times 0.028317 \times 10^{-3}$	= 1,600
			15,700

$$E_{18} = 5,230 \text{ mg/min}$$

$$E_{\text{Dross/Reverb}} = 4,320 + 5,230 = 9,550 \text{ mg/min}$$

Location	Run	Concentration[a/] (μg/m^3)			Flow (fpm)	Effective Area (sq ft)	Wind		Remarks
		Total Part.	Pb	As			Dir. (deg.)	Vel. (fpm)	
19	28	5,170	-	-	100 (v)	480	35	820	All conc. values used.
19	29	7,320	1,420	103	100 (v)	480	270	915	
19	30	4,280	636	54.2	100 (v)	480	345	510	
19	32	18,400	1,100	290	100 (v)	480	275	1,125	
19	33	1,570	95.9	23.8	100 (v)	480	340	535	
20	28	2,730	-	-	150 (v)	30	35	820	All conc. values used.
20	29	15,300	738	167	150 (v)	30	270	915	
20	30	5,900	682	55.6	150 (v)	30	345	510	
20	32	10,700	642	105	150 (v)	30	275	1,125	
20	33	3,590	-	-	150 (v)	30	340	535	

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a/ Standard conditions.

Total Particulates:

Location	Run		
19	28	$E = 5{,}170 \times 100 \times 480 \times 0.028317 \times 10^{-3}$ =	7,030
19	29	$E = 7{,}320 \times 100 \times 480 \times 0.028317 \times 10^{-3}$ =	9,950
19	30	$E = 4{,}280 \times 100 \times 480 \times 0.028317 \times 10^{-3}$ =	5,820
19	32	$E = 18{,}400 \times 100 \times 480 \times 0.028317 \times 10^{-3}$ =	25,000
19	33	$E = 1{,}570 \times 100 \times 480 \times 0.028317 \times 10^{-3}$ =	2,130
			49,900

$E_{19} = 9{,}980$ mg/min

Location	Run		
20	28	$E = 2{,}730 \times 150 \times 30 \times 0.028317 \times 10^{-3}$ =	348
20	29	$E = 15{,}300 \times 150 \times 30 \times 0.028317 \times 10^{-3}$ =	1,950
20	30	$E = 5{,}900 \times 150 \times 30 \times 0.028317 \times 10^{-3}$ =	752
20	32	$E = 10{,}700 \times 150 \times 30 \times 0.028317 \times 10^{-3}$ =	1,360
20	33	$E = 3{,}590 \times 150 \times 30 \times 0.028317 \times 10^{-3}$ =	457
			4,870

$E_{20} = 974$ mg/min

$E_{\text{Blast Furnace}} = E_{19} + E_{20} = 9.980 + 974 = 11{,}000$ mg/min

Lead:

Location	Run		
19	29	$E = 1,420 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 1,930
19	30	$E - 636 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 864
19	32	$E = 1,100 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 1,500
19	33	$E = 95.9 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 130
			4,420

$E_{19} = 1,100$ mg/min

Lead:

Location	Run		
20	29	$E = 738 \times 150 \times 30 \times 0.028317 \times 10^{-3}$	= 94.0
20	30	$E = 682 \times 150 \times 30 \times 0.028317 \times 10^{-3}$	= 86.9
20	32	$E = 642 \times 150 \times 30 \times 0.028317 \times 10^{-3}$	= 81.8
			263

$E_{20} = 87.7$ mg/min

$E_{\text{Blast Furnace}} = 1,100 + 87.7 = 1,190$ mg/min

Arsenic:

Location	Run		
19	29	$E = 103 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 140
19	30	$E = 54.2 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 73.7
19	32	$E = 290 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 394
19	33	$E = 23.8 \times 100 \times 480 \times 0.028317 \times 10^{-3}$	= 32.3
			640

$E_{19} = 160$ mg/min

Arsenic:

Location	Run		
20	29	$E = 167 \times 150 \times 30 \times 0.028317 \times 10^{-3}$	= 21.3
20	30	$E = 55.6 \times 150 \times 30 \times 0.028317 \times 10^{-3}$	= 7.08
20	32	$E = 105 \times 150 \times 30 \times 0.028317 \times 10^{-3}$	= 13.4
			41.8

$E_{20} = 13.9$ mg/min

$E_{\text{Blast Furnace}} = 160 + 13.9 = 174$ mg/min

Location	Run	Concentration[a/] ($\mu g/m^3$) Total Part.	Pb	As	Flow (fpm)	Effective Area (sq ft)	Wind Dir. (deg.)	Wind Vel. (fpm)	Remarks
21	23	2,140	-	-	440	129	305	440	All conc. values
21	25	1,420	129	4.77	970	129	315	970	were used
22	23	569	-	-	50 (v)	180	305	840	
22	25	706	50.3	4.18	50 (v)	180	285	1,815	

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a/ Standard conditions.

Total Particulates:

Location	Run	
21	23	$E = 2,140 \times 440 \times 129 \times 0.028317 \times 10^{-3} = 3,440$
21	25	$E = 1,420 \times 970 \times 129 \times 0.028317 \times 10^{-3} = \underline{5,030}$
		8,470

$$E_{21} = 4,240$$

Location	Run	
22	23	$E = 569 \times 50 \times 180 \times 0.028317 \times 10^{-3} = 145$
22	25	$E = 706 \times 50 \times 180 \times 0.028317 \times 10^{-3} = \underline{180}$
		325

$$E_{22} = 162$$

$$E_{\text{Zinc Fuming}} = E_{21} + E_{22}$$

$$= 4,240 + 162 = 4,400 \text{ mg/min}$$

Lead:

Location	Run	
21	25	$E = 129 \times 970 \times 129 \times 0.028317 \times 10^{-3} = 457$ mg/min

Lead:

Location	Run	
22	25	$E = 50.3 \times 50 \times 180 \times 0.028317 \times 10^{-3} = 12.8$ mg/min

$$E_{\text{Zinc Fuming}} = E_{21} + E_{22} = 457 + 12.8 = 470 \text{ mg/min}$$

Arsenic:

Location	Run	
21	25	$E = 4.77 \times 970 \times 129 \times 0.028317 \times 10^{-3} = 16.9$ mg/min

Arsenic:

Location	Run	
22	25	$E = 4.18 \times 50 \times 180 \times 0.028317 \times 10^{-3} = 1.06$ mg/min

$$E_{\text{Zinc Fuming}} = E_{21} + E_{22} = 16.9 + 1.06 = 18.0 \text{ mg/min}$$

		Concentration[a/] ($\mu g/m^3$)				Effective	Wind		
Location	Run	Total Part.	Pb	As	Flow (fpm)	Area (sq ft)	Dir. (deg.)	Vel. (fpm)	Remarks
23	23	3,980	-	-	475 (v)	214	305	680	Runs 23 to 27 conc. values used
23	24	3,320	269	1.55	500 (v)	214	270	1,350	
23	25	5,690	744	18.4	400 (v)	214	288	1,655	
23	26	3,200	-	-	450 (v)	214	273	1,935	
23	27	3,620	165	21.2	400 (v)	214	260	1,120	
23A	23	3,890	-	-	1,135	Amb.	292	1,135	This was an ambient air background sampler.
23A	24	1,230	30.6	1.40	1,320	Amb.	267	1,320	
23A	25	3,280	-	-	1,655	Amb.	288	1,655	
23A	26	3,030	71.8	3.64	1,935	Amb.	273	1,935	
23A	27	1,750	12.0	0.63	1,055	Amb.	260	1,055	

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a/ Standard conditions.

Total Particulates:

Location	Run	
23	23	$E = 3,980 \times 475 \times 214 \times 0.028317 \times 10^{-3} = 11,400$
23	24	$E = 3,320 \times 500 \times 214 \times 0.028317 \times 10^{-3} = 10,100$
23	25	$E = 5,690 \times 400 \times 214 \times 0.028317 \times 10^{-3} = 13,800$
23	26	$E = 3,200 \times 450 \times 214 \times 0.028317 \times 10^{-3} = 8,730$
23	27	$E = 3,620 \times 400 \times 214 \times 0.028317 \times 10^{-3} = 8,770$
		52,800

$E_{23} = 10,600$

$E_{\text{Zinc Furnace}} = E_{23} = 10,600$ mg/min

Lead:

Location	Run	
23	24	$E = 269 \times 500 \times 214 \times 0.028317 \times 10^{-3} = 815$
23	25	$E = 744 \times 400 \times 214 \times 0.028317 \times 10^{-3} = 1,800$
23	27	$E = 165 \times 400 \times 214 \times 0.028317 \times 10^{-3} = 400$
		3,020

$E_{\text{Zinc Furnace}} = E_{23} = 1,010$ mg/min

Arsenic:

Location	Run	
23	24	$E = 1.55 \times 500 \times 214 \times 0.028317 \times 10^{-3} = 4.70$
23	25	$E - 18.4 \times 400 \times 214 \times 0.028317 \times 10^{-3} = 44.6$
23	27	$E = 21.2 \times 400 \times 214 \times 0.028317 \times 10^{-3} = 51.4$
		101

$E_{\text{Zinc Furnace}} = E_{23} = 33.7$ mg/min

		Concentration[a] (µg/m^3)				Effective	Wind		
Location	Run	Total Part.	Pb	As	Flow (fpm)	Area (sq ft)	Dir. (deg.)	Vel. (fpm)	Remarks
24N	23	2,380	-	-	210	Amb.	900-1130 360° 1130-1630 Var.	210	Because of the wind direction, these were only ambient air background concentrations.
24N	25	4,870	-	-	465	Amb.	Var.	465	
24S	23	3,640	-	-	210	Amb.	900-1130 360° 1130-1630 Var.	210	
24S	25	3,980	865	18.5	465	Amb.	Var.	465	

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[a] Standard conditions.